PUBLIC WORKS

Dec. 1951

CITY, COUNTY AND STATE

Curb and Gutter Machine Speeds Work

Better Sewage Treatment for Denver

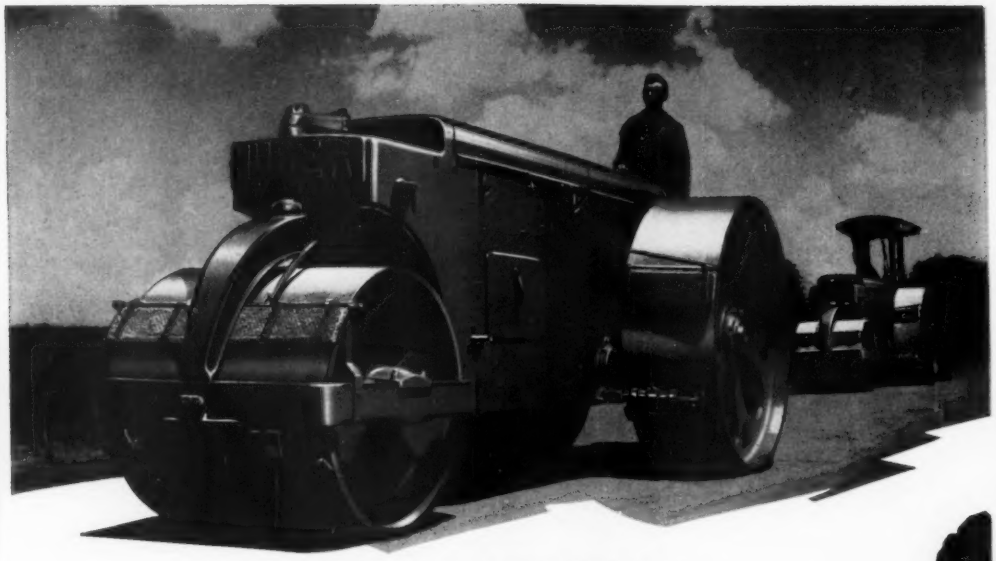
Winston-Salem Gets New Water Plant

Building an Elevated Highway for Seattle

Better Water Supply Facilities for Cincinnati

Chemical Sludge Treatment for Small Plants

Dean Edward E. Stapley of Oklahoma Institute of Technology, Stillwater, Oklahoma, a leader in engineering education. More on page 26.



Solve Compaction Problems

EFFICIENTLY, QUICKLY, DEPENDABLY

With

HUBER *GENERAL - PURPOSE* 3-Wheel ROLLERS

8-10-12-14 TONS • GASOLINE-DIESEL

Since Huber pioneered the "automotive-type" roller in 1923, it has led the industry in the refinement of these versatile machines. Huber has made 3-wheel rollers truly general purpose machines.

FOR GRADE WORK, the Huber 3-wheel is widely used for compaction of earthworks, embankments, sub-grades, trenches and insulation courses. These rollers usually are equipped with 18" face rolls on the 8-ton units, and 20" face rolls on the 10, 12, 14 ton sizes to gain maximum compaction per lineal inch.

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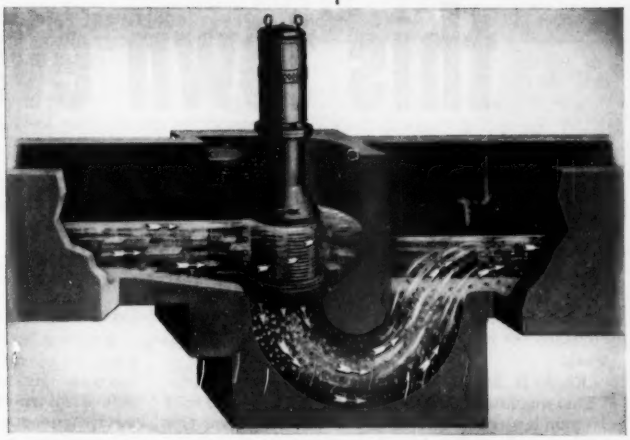
HUBER

CHICAGO COMMINUTORS

cut coarse sewage matter into small settleable solids without removal from channel



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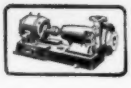

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The 1951 volume of Public Works will be available on microfilm through University Microfilms, 313 N. First St., Ann Arbor, Mich.

THE ENGINEERING AUTHORITY IN THE CITY-COUNTY--STATE FIELD

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THE EDITOR'S POINT OF VIEW

Is There a Santa Claus for Engineers?

SOON after this copy of PUBLIC WORKS reaches its readers, the year-end holidays will be here. To all of our readers, we wish the best of prosperity and happiness for 1952, a relief from the tensions of the present, and a recognition of the needs for and values of engineering skills. We have sometimes questioned whether Santa Claus and engineers were on good terms; and we have some mental reservations as to the causes, if any: whether a myopia on the part of Santa or that certain contrary stubbornness which cause so many engineers to neglect the public relations side of their profession.

Whatever that situation is, we congratulate the engineering and public works professions on a year of outstanding accomplishments; and we wish for them for the future a fuller opportunity for service and a broader appreciation of their many contributions to a better world.

What About This Shortage of Engineers?

A survey of 378 companies and governmental agencies last June showed a need for about 80,000 engineers. This did not include the needs of the military. The 1951 graduating class of 38,000 was insufficient to meet these needs, the more so that the military services, through Selective Service, ROTC and the reserve withdrew about half of the 1951 graduates from normal channels. In other words, as of now, there is a shortage of some 60,000 engineers. This deficit cannot be met through current production of engineers. It is estimated that about 26,000 engineers will be graduated in 1952, 17,000 in 1953 and 12,000 in 1954.

The Bureau of Labor Statistics estimates that about 1600 engineers are required per 100,000 workers. This is independent of military needs for which precise figures are not available for publication. In any case, there is a serious shortage of engineers, with no indication that the situation will get any better quickly.

The above data, which are reported by the Engineers Joint Council, emphasize the need for utilizing to the utmost the abilities and skills of the existing supply of engineers. This applies not only to industry, but also to governmental agencies and the military services, both of which are normally wasteful of scientific skills. It should also apply to the various overseas programs in which our engineers are being employed, not infrequently under foreign personnel unfamiliar with their capacities and skills.

We do not like to set up a problem without attempting to suggest a solution. In this case, however, a solution seems difficult or impossible, with mitigation the sole relief. The only organized groups in engineering are the professional societies. These societies should set up appropriate committees to work with such agencies as the military, the government and the overseas employers of engineers, to the end that these agencies may utilize engineers most effectively.

Professional Engineering in the Air Force

IT is regrettable that it was not possible to have included in the recently passed Air Force Organization Act a statement in respect to professional engineers, such as was incorporated in the Army Reorganization Act of a couple of years ago. In the past, the Air Force has been notably careless—inept might be a better word—in judging whether or not a man was an engineer. As a result, men with no more than a thin wash of experience in jobs allied to engineering held some important engineering positions in the Air Force organization.

We have no particular quarrel with the Air Force plan to avoid all Corps, Services and Branches. We think it can work fine to have everyone wear the same uniform and the same insignia, no matter what his profession or his skill. It will be necessary, however, for Air Force personnel to acquire the ability to read, understand and utilize occupational specialty numbers, a skill in which many higher officers have been notably deficient in the past.

If a system can be set up which will analyze the needs for engineering skills, require the sound evaluation of an officer's experience and background, assign a suitable occupational specialty number and adhere rigidly to this for all assignments, there should be little to worry about in regard to the proper utilization of engineers. But it is an awful big "if."

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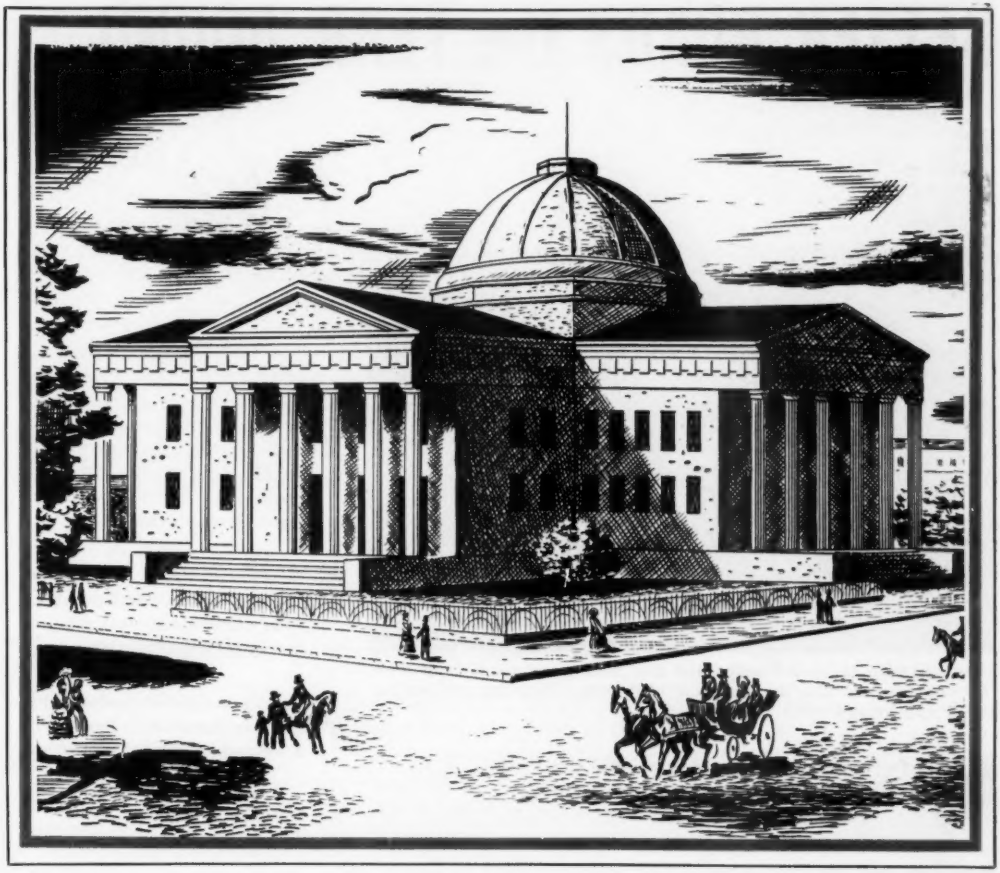

The old courthouse in St. Louis as it looked 100 years ago

St. Louis, Missouri has a cast iron water main in service that was installed more than 100 years ago. That is not surprising as St. Louis is one of our oldest cities, founded by the French and taken over by the U. S. A. with the Louisiana Purchase. Yet this old main is still withstanding the traffic shock and beam stresses imposed by multi-ton trucks and congested underground utility services in a great manufacturing city. More than thirty other American cities have cast iron water and gas mains in service that were installed over a century ago—indisputable testimony to the strength factors of long life inherent in cast iron pipe.

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PIPE
FOR WATER AND GAS

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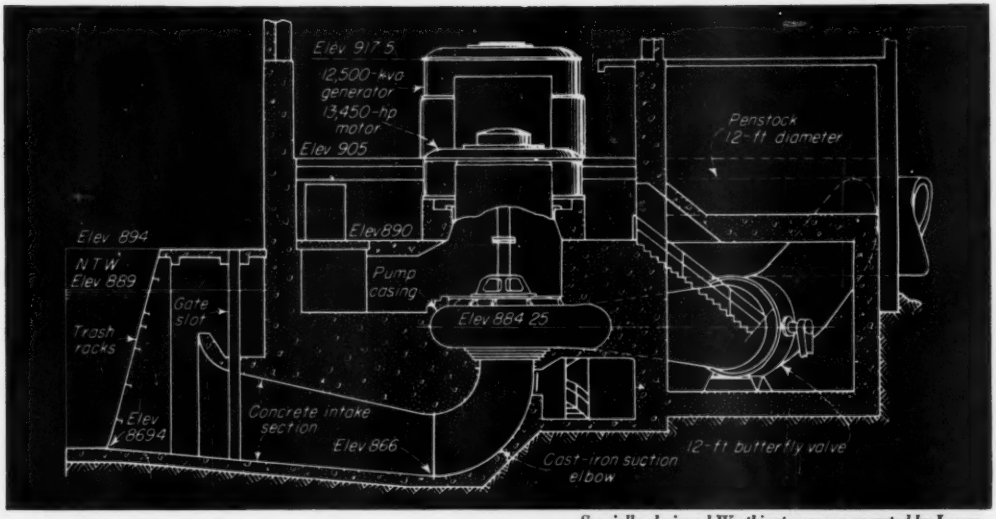
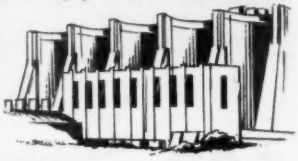


Specially-designed Worthington pump operated by Lower Colorado River Authority of Texas, at Buchanan Dam.

Big Pump Banks Hydro Energy

at 360,000 gpm—and low cost!



It's one of the largest in the world—the Worthington pump used for water storage at Buchanan Dam on the Colorado River in Texas.

There are three 12,500 kva generators at Buchanan Dam. The pump is used in connection with the third one. It uses low-cost off-peak energy to store water which can be used at times of peak load.

The cost of running the pump is only one-quarter the value of the peak energy it helps to produce.

This specially-designed pump is rated at 362,000 gpm under 120 ft head, and is driven by a 13,450 hp motor. It has a 164 rpm shaft, bottom-suction, twin-volute, closed-impeller design. The impeller's center line is 4.75 ft below normal tail water level. So the pump is primed at all times and there is no cavitation of the impeller.

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It's another case that proves *there's more worth in Worthington*—proves that Worthington can always supply the right pump for the job. It makes no difference whether tremendous quantities of water are involved as at Buchanan or the relatively smaller amounts required by the average municipality. With the broadest and most complete line in the world, it is often possible to select or adapt a standard model to meet specifications. For detailed information, address Worthington Pump and Machinery Corporation, Public Works Division, Harrison, N. J.

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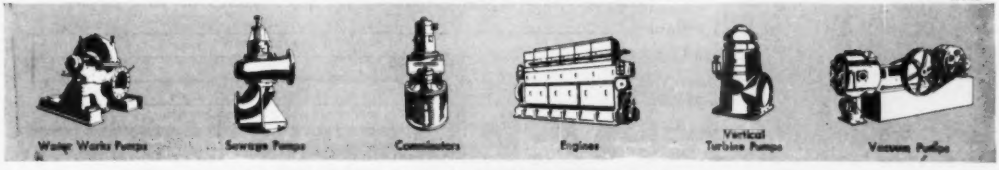

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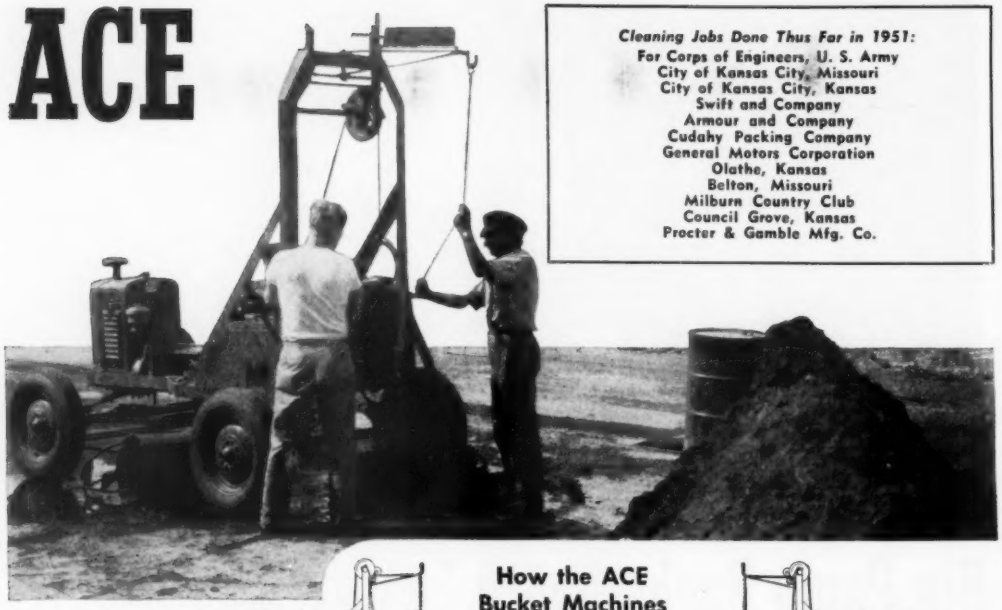

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Cudahy Packing Company
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Council Grove, Kansas
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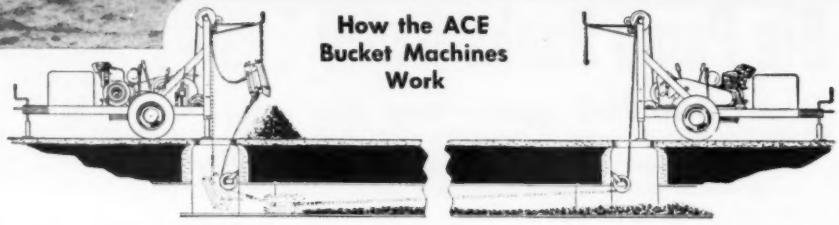

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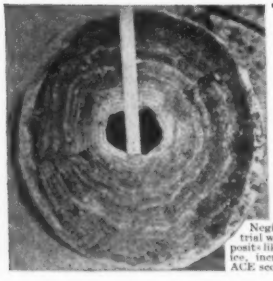

Neglected city and industrial water pipes fill with deposits like this—cut down service, increase fire rates. Let ACE scour them *clean* for you.

OK ***I want to See:***

☐ Your new 21-minute movie of the Kansas City Flood.*
☐ Your Company representative. ☐ More details on your service.

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Title_____
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Street_____
City and State_____

*Shows 9 minutes of disastrous July, '51 flood, and 12 of aftermath clean-up of flood-clogged sewers, by ACE crews. Taken right on the job!

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Coming through! Owned by Lincoln County, Washington, this "Caterpillar" Diesel No. 12 Motor Grader is busy on snow removal near Davenport. An essential highway tool, the No. 12 also earns its keep during the year by building and maintaining roads. As a military tool, it's essential for airport construction and maintenance, road construction, the establishment of bases and scores of other earthmoving jobs.

HOW TO GET MORE WORK FROM YOUR "CAT" MOTOR GRADER!

HERE's the situation in a nutshell. The speed, versatility and big work capacity that have made "Cat" Motor Graders so essential a year-round tool for road work have also made them essential to the armed forces. As military orders must be filled first, you may not be able to obtain prompt delivery of new machines. So it's to your advantage to plan now to get more work from your present equipment—and keep it ready for any emergency.

"Cat" Motor Graders are ruggedly built for long life. But good care on your part can lengthen that life span by thousands of extra service hours. Here's how:

1. **Follow the recommended *operating* care in your Operator's Instruction Book. Read and reread it.**
2. **Observe the *maintenance* suggestions in the Operator's Instruction Book. They're down-to-earth—experience has proved them practical and effective.**
3. **Anticipate your future replacement parts needs by seeing your "Caterpillar" dealer about them *now*. Don't wait until wear gets beyond repair—many a part can be rebuilt *if* serviced in time.**

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compact **Infilco** *plant softens 4 M.G.D. with ACCELATOR only 44 ft. in dia.*

clear, non-corrosive soft water with

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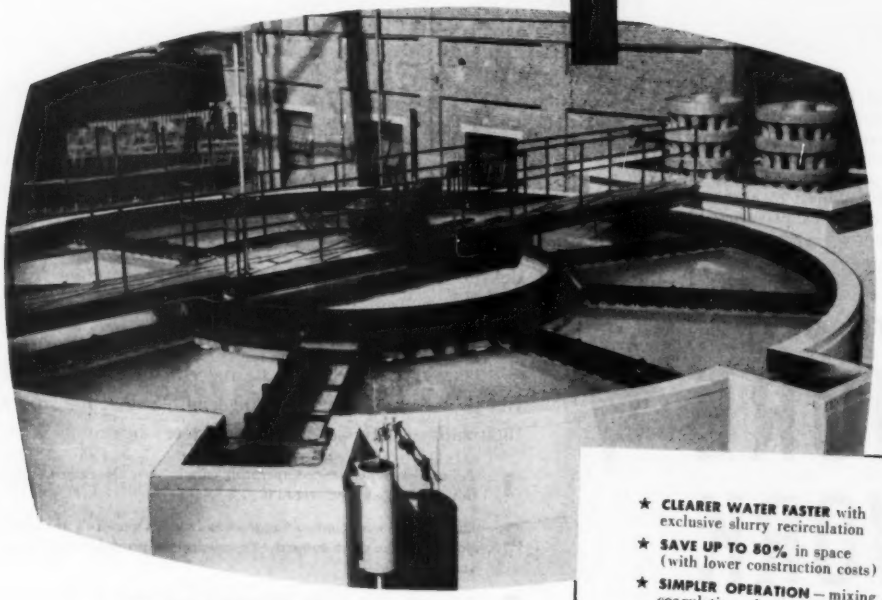

★ **CLEARER WATER FASTER** with exclusive slurry recirculation
★ **SAVE UP TO 80%** in space (with lower construction costs)
★ **SIMPLER OPERATION** — mixing, coagulation, clarification and sludge removal all in one unit
★ **FASTER CHEMICAL REACTION**
★ **HIGH RATINGS**

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44 ft. diameter Accelator — with automatic chemical feeders and central controls. 2 Multicone Aerators
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Serves population of 11,588 with average daily use of 1.5 m.g.d. and capacity of 4.0 m.g.d.

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Removable cylinder liners ... with integrally cast leakproof waterjacket ...

Dome-shaped cylinder heads ... for improved combustion and cooling ...

Improved connecting rod design ... pistons and rods may be removed without disturbing crankpin bearings ...

Oil-cooled pistons ... for longer piston ring and liner life ...

Simple controls ... start or stop by the movement of a single lever. Hydraulic governor speed control ...

Use this Coupon!

Fairbanks, Morse & Co.,
600 South Michigan Ave.,
Chicago 5, Illinois

Send me a copy of the new bulletin on the Model 31A18 Oil Diesel and Dual Fuel engine.

Name_____

Position_____

Address_____

City_____ State_____

★

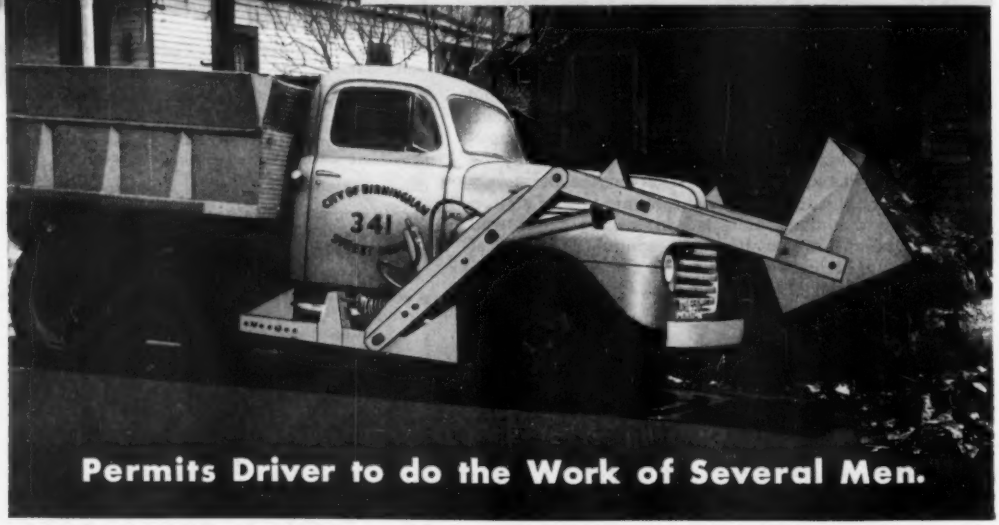
New
HOLMES
OWEN
LOADER

REDUCES COST
of maintenance on STREETS and PARKS

IMPORTANT municipalities such as the City of Birmingham, Ala.; Cincinnati, Ohio; Kansas City, Mo.; Philadelphia, Pa. and many others are today profitably using Holmes-Owen truck loaders. These key cities have put this equipment into operation because it substantially reduces the cost of many loading and cleaning up operations in the maintenance of streets, parks, airports, etc. This new loader provides a big saving in labor and equipment on such jobs as: picking up the leavings behind a street sweeper, removal of broken and bulky concrete, leaves, trash and other street deposits. It also makes an excellent unit for the removal of snow and handling of ashes, sand, and other stock pile materials.

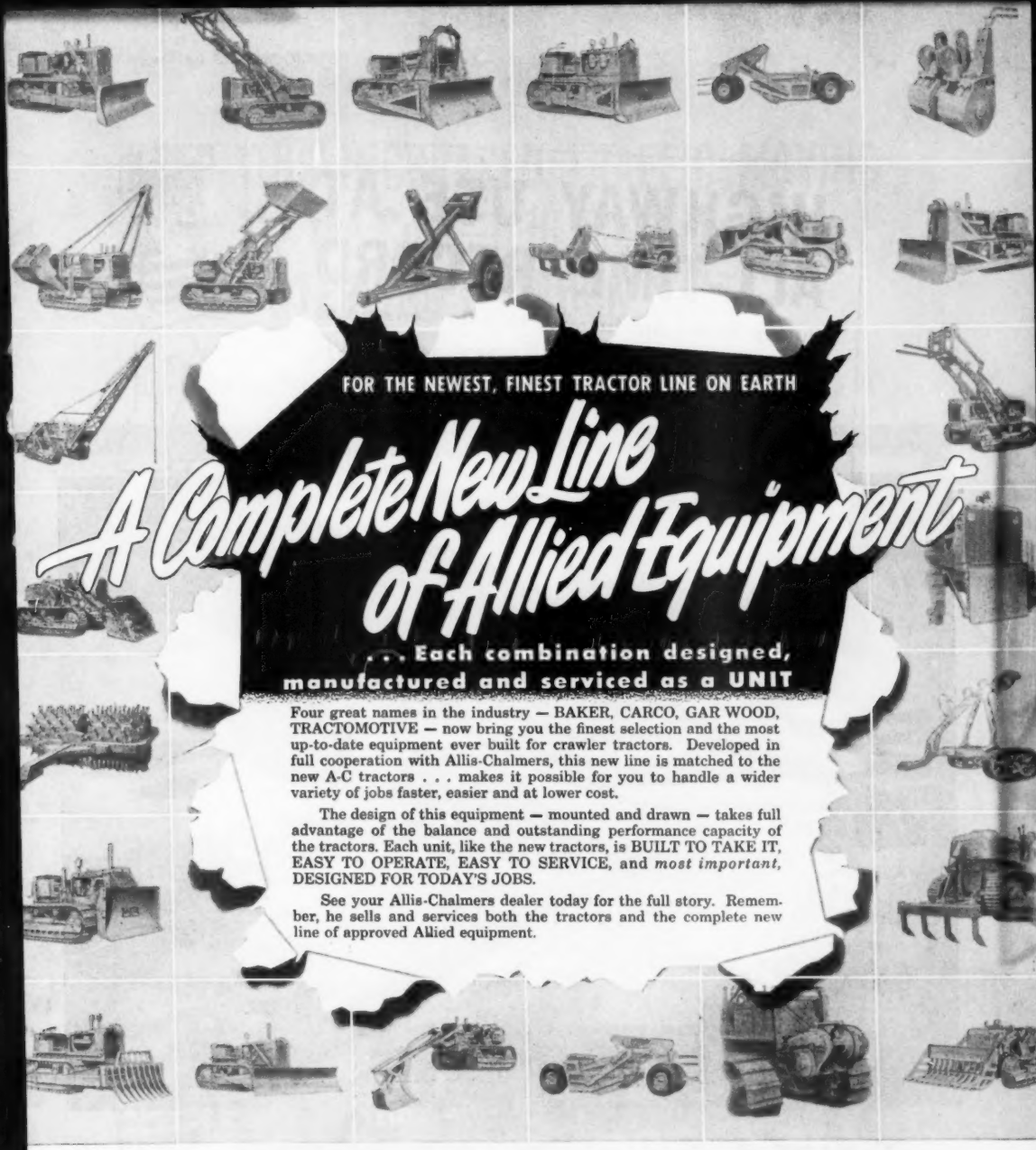
The versatile, one-man operation of this equipment permits the truck driver to do his own light digging, grading, loading and cleaning-up without additional manpower or the use of more costly equipment. The loader is hydraulically operated, lifts ½ yard per bucket; loads average truck in 4 minutes and can be installed on most 1½ to 2½ ton trucks. See your equipment dealer or write factory for details.

ERNEST HOLMES CO., Chattanooga, Tenn.



Permits Driver to do the Work of Several Men.

Need more facts about advertised products? Mail your Readers' Service card now.



FOR THE NEWEST, FINEST TRACTOR LINE ON EARTH

A Complete New Line of Allied Equipment

. . . Each combination designed, manufactured and serviced as a UNIT

Four great names in the industry — BAKER, CARCO, GAR WOOD, TRACTOMOTIVE — now bring you the finest selection and the most up-to-date equipment ever built for crawler tractors. Developed in full cooperation with Allis-Chalmers, this new line is matched to the new A-C tractors . . . makes it possible for you to handle a wider variety of jobs faster, easier and at lower cost.

The design of this equipment — mounted and drawn — takes full advantage of the balance and outstanding performance capacity of the tractors. Each unit, like the new tractors, is BUILT TO TAKE IT, EASY TO OPERATE, EASY TO SERVICE, and *most important*, DESIGNED FOR TODAY'S JOBS.

See your Allis-Chalmers dealer today for the full story. Remember, he sells and services both the tractors and the complete new line of approved Allied equipment.

Years Ahead

Each of the new Allis-Chalmers crawlers provides a new yardstick for rating tractors. Each sets new standards for performance, strength, servicing, operation.

HD-5 40.26 drawbar hp.; 11,250 lb.
HD-9 72 drawbar hp.; 18,800 lb.
HD-15 109 drawbar hp.; 27,850 lb.
HD-20 175 net engine hp.; 41,000 lb. Hydraulic Torque Converter Drive

ALLIS-CHALMERS

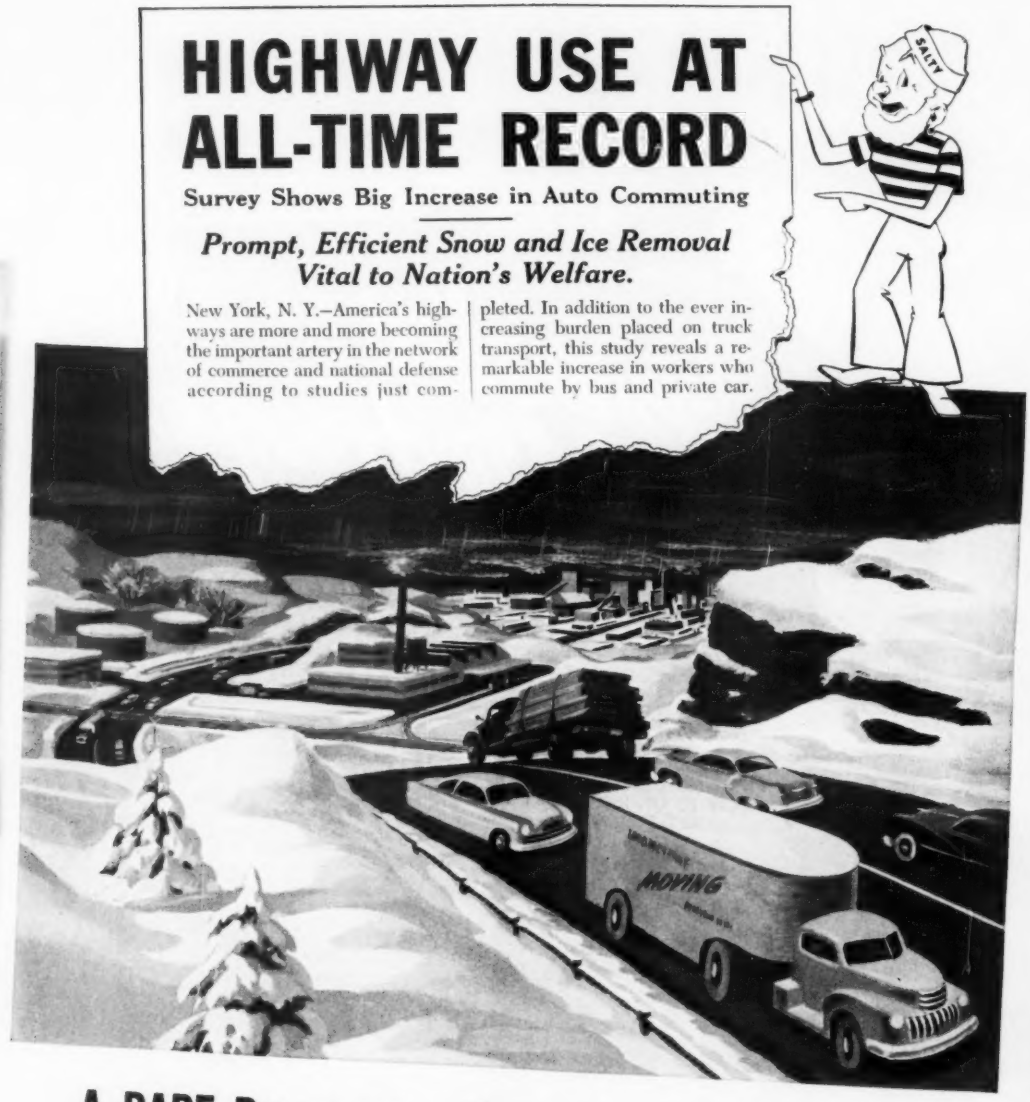
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

HIGHWAY USE AT ALL-TIME RECORD

Survey Shows Big Increase in Auto Commuting

Prompt, Efficient Snow and Ice Removal Vital to Nation's Welfare.

New York, N. Y.—America's highways are more and more becoming the important artery in the network of commerce and national defense according to studies just completed. In addition to the ever increasing burden placed on truck transport, this study reveals a remarkable increase in workers who commute by bus and private car.



A BARE Pavement...The Only SAFE Pavement

Exclusive use of STERLING *Auger-Action* ROCK SALT makes snow and ice removal faster, easier, more economical than outmoded abrasive chemical methods. Each coarse rock salt crystal bores through ice and snow right down to the pavement. Here it changes to brine that breaks the bond between the ice and the road surface. Heavy traffic spots clear themselves with passage of vehicles. Other areas come summer-clear with one pass of the plow or scraper—to give you a *bare, safe pavement.*

Thousands use our Readers' Service card to keep up to date . . . do you?

KEEP THIS INCREASED TRAFFIC MOVING at 1/2 the Cost—1/10 the Time with STERLING Auger-Action ROCK SALT

Experience Proves It! Here's How One Snow Belt County Saved Time and Money With Sterling Auger-Action Rock Salt

Comparative costs of protecting icy highways with treated sand and rock salt

SAND MIXED WITH ROCK SALT:

Royalty	$ .10
Loading	.25
Haul, 5 miles at 8¢	.40
Piling with bulldozer	.15
Treating with salt at 50 lbs. per cu. yd.	.48
Reloading at time of storm	.25
Average haul, 10 miles at 8¢	.80
Spread	.10
Total cost per cu. yd.	**$ 2.53**
Use of 3 cu. yd. per mile at $2.53	**7.59**

STRAIGHT ROCK SALT:

CC Grade Rock Salt (400 lb. per mile, computed for 5-ton load):

5 tons of bulk salt at $12.95 per ton	$64.75
Loading, 5 tons at 25¢ per ton	1.25
Average haul (30 miles at 8¢ per ton-mile) 5 tons	12.00
Spread (mechanical) 5 tons at $1.00	5.00
	$83.00
$83.00/5 ton per ton =	**16.60**
$83.00/25 miles per mile =	**3.32**

UNIT SAVINGS:

$7.59 cost per mile with treated sand

$3.32 cost per mile with Sterling Rock Salt

$4.27 SAVING PER MILE EACH ICING IN FAVOR OF ROCK SALT

Mileage of state highways = 216 miles

ESTIMATED SAVING EACH STORM:

216 x $4.27 ..... $922.32

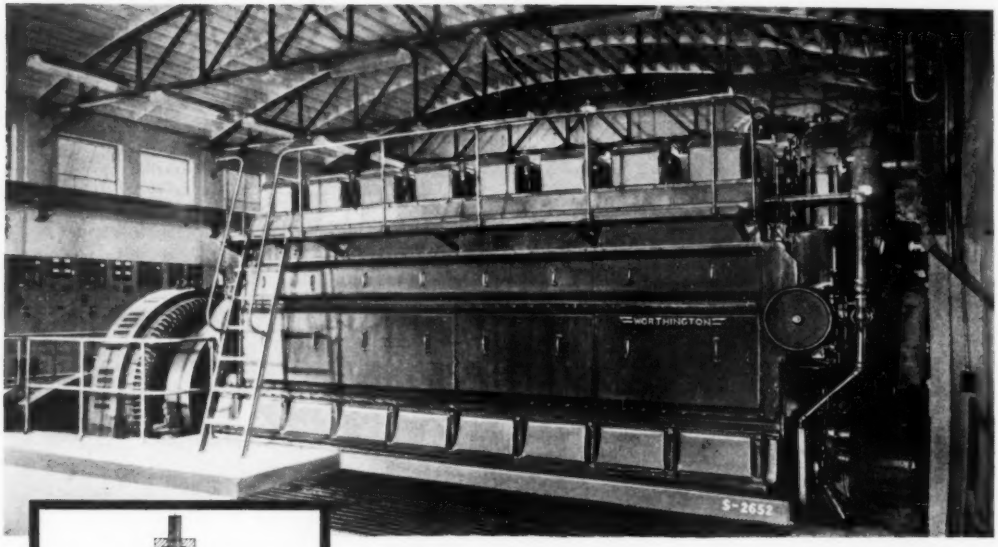
Safe Pavements Are More Vital Than Ever!

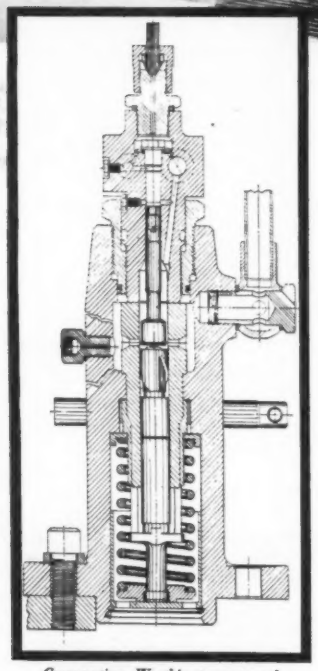
For a Safer Winter . . . ORDER NOW

STERLING AUGER-ACTION ROCK SALT

Comes in carloads, bulk, or 100-lb. bags

INTERNATIONAL SALT COMPANY, INC.
Scranton 2, Pa.





Cross-section, Worthington patented dual plunger fuel pump.

This Diesel Is Ready

FOR A CHANGE IN DIET

Right now this Worthington Diesel—one of three 1760 hp units owned by the city of Tarboro, N. C.—is operating on oil.

But they anticipate natural gas in this area, and this Diesel is ready for it. With slight changes, it can easily be converted.

Worthington's patented dual plunger pumps now completely fuel this engine with oil—producing more perfect atomization, making possible the use of a *heavier* grade of oil. Also: firing pressures are reduced, exhaust temperatures, too, and combustion is improved.

When the conversion to gas is made, the dual plunger pumps will furnish pilot oil for ignition. Conversion is made quickly and at low cost.

For any engine application, call on Worthington—an engine for any fuel: oil (crude or regular), gas or "dual fuel". Worthington's complete line of engines assures you of the most economical operation no matter what fuel you use.

Only Worthington dual fuel engines offer such exclusives as dual plunger pumps, gas micro-metering valves for each cylinder, and automatic thermal air control—all built to give optimum performance for the fuel used.

Write for Bulletin S-500-B 31 C, Worthington Pump and Machinery Corporation, Engine Division, Buffalo, New York.

WORTHINGTON

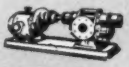
ENGINES E1.12

ECONOMICAL CONTINUOUS POWER

Diesel Engines, 150 to 2640 hp
Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

WORTHINGTON-BUILT AUXILIARIES

Engine Starting Compressors



Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Coolers

Get full details of this month's new products . . . mail your Readers' Service card today.

OPERATING GUARANTEES EXCEEDED ON EVERY COUNT

by Dorrco Hydro-Treators* at Miami's new Southwest plant.

here are the facts...

In May 1951, the four 69′ dia. Dorrco Hydro-Treators installed at the City of Miami's new softening plant near Coral Gables were put in operation. Complete operating results now available show that guarantees have been exceeded on every count.

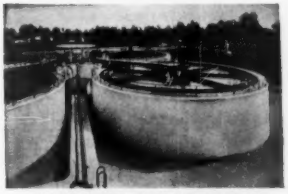
	GUARANTEED	ACTUAL
Capacity—MGD/unit—maximum	13.33	17.5
Turbidity—ppm at maximum flow	10.0	Less than 8
—ppm at average flow	5-10	±2
Percent solids in sludge	30	45-48
Power required/unit—KW	2.0	1.74
pH	**10.0	9.8-10.2
Alkalinity-Phenolphthalein—ppm	**20.0	±1
Methyl Orange—ppm	**40.0	23
Total Hardness	**79.0	45
Activated silica as reagent—ppm	**4	2

Stable effluent is being produced by Hydro-Treator without further treatment.

** Estimated at time of bidding.

We believe these results speak for themselves. If you'd like further information on Hydro-Treators write for Bulletin #9041 . . . 28 pages of drawings, description and useful data. Please address your request to The Dorr Company, Engineers, Stamford, Conn.; or in Canada, The Dorr Company, 80 Richmond Street West, Toronto 1.

* Reg. U.S. Pat. Off.



MIAMI'S FOUR NEW HYDRO-TREATORS

DORRCO

DORR

WORLD - WIDE RESEARCH · ENGINEERING · EQUIPMENT

THE DORR COMPANY · ENGINEERS · STAMFORD, CONN.

Offices, Associated Companies or Representatives in the principal cities of the world

Need more facts about advertised products? Mail your Readers' Service card now.

HELTZEL

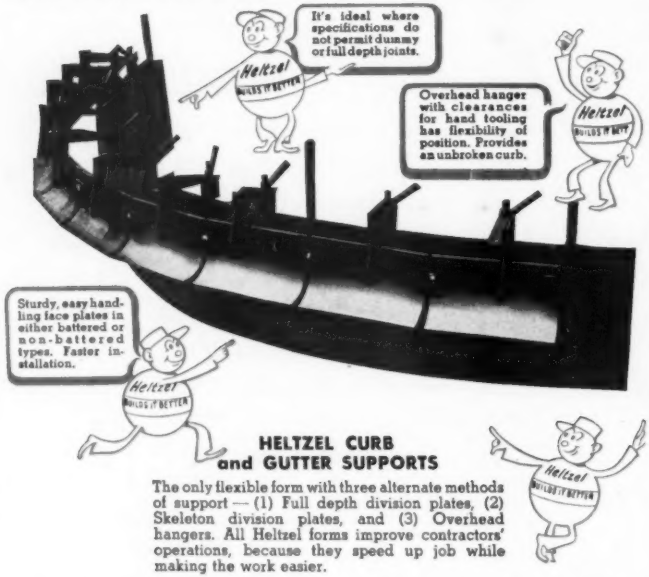
Heltzel BUILDS IT BETTER

SUPERIOR Forms

CURB & GUTTER

Demand for Heltzel forms comes from experienced contractors who know Heltzel forms save time and money. TIME — because firmer installations can be made faster. MONEY — because Heltzel equipment lasts longer and involves less labor on the job. The example below of a flexible form is typical of Heltzel better built forms.

- CURB FORMS & ACCESSORIES
- COMBINED CURB & GUTTER
- SIDEWALK FORMS
- RIGID RADIUS FORMS
- FLEXIBLE FORMS
- SPECIAL FORMS


It's ideal where specifications do not permit dummy or full depth joints.
Overhead hanger with clearances for hand tooling has flexibility of position. Provides an unbroken curb.
Sturdy, easy handling face plates in either battered or non-battered types. Faster installation.
Heltzel BUILDS IT BETTER

HELTZEL CURB and GUTTER SUPPORTS

The only flexible form with three alternate methods of support — (1) Full depth division plates, (2) Skeleton division plates, and (3) Overhead hangers. All Heltzel forms improve contractors' operations, because they speed up job while making the work easier.

PUT HELTZEL TO WORK MAKING MONEY FOR YOU

Before you buy, before you start a job — check with Heltzel! Heltzel better built curb and gutter forms in standard types will save for you. Special shapes designed by Heltzel to job specifications make difficult jobs click like run-of-mine work. Write for information now.

HELTZEL STEEL FORM & IRON CO., WARREN, O., U.S.A.

Please send information regarding:

CURB and GUTTER FORMS _____

ROAD and AIRPORT FORMS _____

BATCHING PLANTS and BINS _____

Firm _____

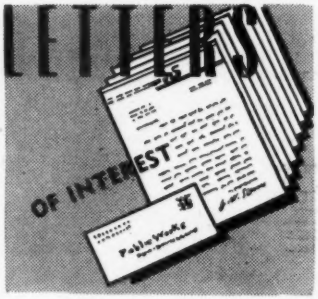
Address _____

City _____ State _____

Signed _____

HELTZEL STEEL FORM & IRON CO. WARREN, OHIO · U. S. A.

Now's the time to mail this month's Readers' Service card.



SURE THING

Have just finished looking through your October issue and I wanted to tell you what an unusually interesting and well laid-out issue it is.

Needless to say, we assume that the pencil shown on page 72 is a Dixon product. Yes?

C. R. Tighe,
Adv. & Sales Promotion,
Joseph Dixon Crucible Co.

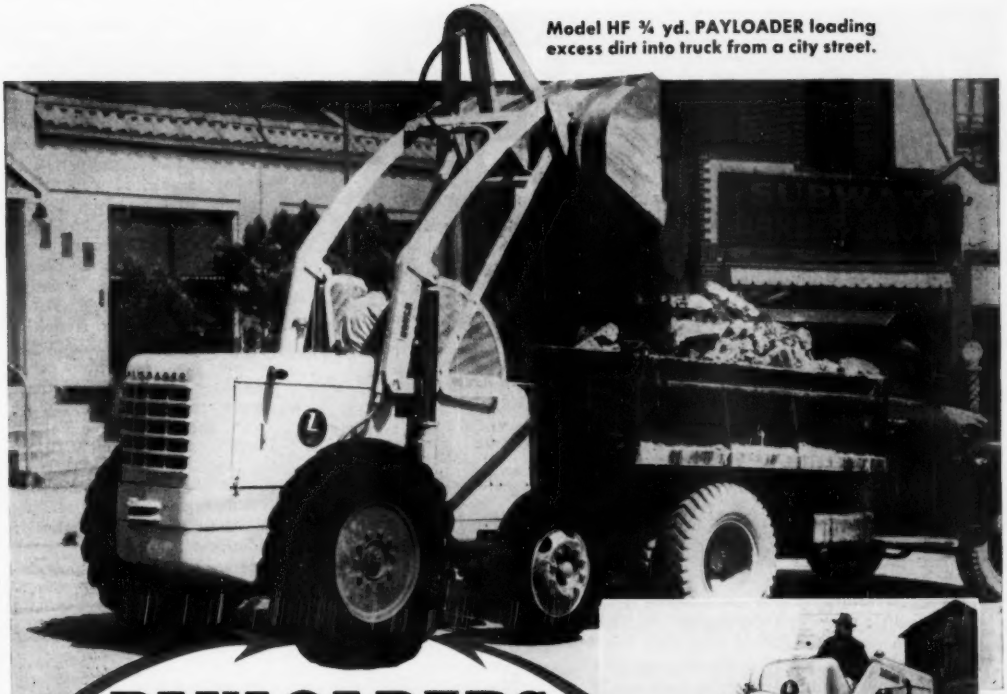
PRIORITIES & ALLOCATIONS

Within the last month, I have been in contact with many of the purchasing agents from the smaller communities and have found that they are beginning to be quite worried about securing materials as far as the Controlled Materials Plan is concerned, and about the various National Production Authority regulations and directives.

In most instances, they are unaware of the material that is available for their use and I suggest that you print such a list. The material that is available from the various sources that would help the officials and which I recommend are as follows:

Subscriptions to:

1. *Defense Production Record*
   It is an official weekly bulletin of the defense production program, which gives a brief resume of the various changes in the National Production Authority regulations issued during the week. Subscription price is $2.50 per year. Secure from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
2. *Abstracts of Defense Regulations*
   This is a new periodical, which is revised monthly, containing a cumulative list of all regu-



Model HF ¾ yd. PAYLOADER loading excess dirt into truck from a city street.

PAYLOADERS ON RUBBER

Are all-around Performers

Performance is the big PAYLOADER feature that has sold hundreds of these special Hough-built tractor-shovels to cities, towns, counties and states . . . their ability to do more jobs faster and better than other tractor-shovels.

One of the big reasons for PAYLOADER superiority is their use of large earthmover tires that give lots of traction and flotation PLUS speed, mobility and economy. They can work and travel safely on streets and get to the job fast under their own power without the use of trailers. Maintenance costs for their pneumatic tires is also less than for crawler tracks especially when used on sand and other abrasive grounds.

When you need a tractor-shovel get PAYLOADER, the complete unit-built tractor-shovel — on *rubber*. There's a size to fit *your* needs. The Frank G. Hough Co., 761 Sunnyside Avenue, Libertyville, Illinois.

Model HM 1½ yd. 4-wheel drive PAYLOADER backfilling a trench.

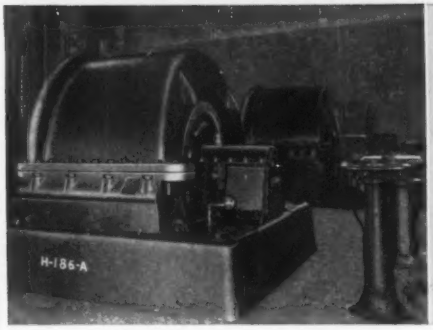
WRITE for literature on any size PAYLOADER — the 4-wheel drive 1½ yd. Model HM; the 1¼ yd. Model HY; the ¾ yd. Model HF; the ½ yd. Model HE; the 12 cu. ft. Model HA. There is no obligation.

PAYLOADER®

Manufactured by THE FRANK G. HOUGH CO.

Thousands use our Readers' Service card to keep up to date . . . do you?

Keep your eye on V-P-I
WHEN SELECTING
BLOWERS



CENTRIFUGAL

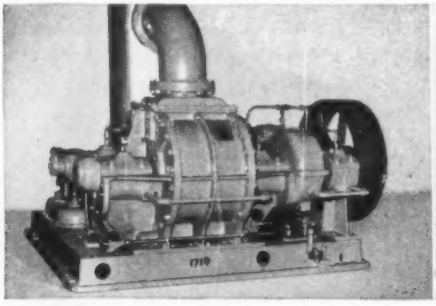
This Type H, 3-Stage Centrifugal Blower, with capacity of 15,000 cfm, is one of many R-C units used by this large eastern city in sewage treatment service.

Sewage treatment plants can't afford to risk shutdowns because of unsatisfactory or inadequate equipment performance. To maintain required rates of flow, calls for blowers that continuously deliver positive Volume at required Pressure—and at Low power costs to reduce operating expense.

You get these 3 essentials from R-C Blowers. Whether your needs call for Centrifugal or Rotary Positive units, we can match them from our exclusive *dual-ability line*. With capacities from 5 cfm to 100,000 cfm, you can usually find R-C units that closely fit your demands, with resultant savings in time, cost, space, weight and power.

From an experience of almost a century of blower building, our engineers will gladly make suggestions of the right R-C equipment for industrial or municipal sewage treatment plants of any size.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Poplar Avenue, Connersville, Indiana



ROTARY

Type RCDH Rotary Positive Blower installation in sewage treatment plant in central New York City. Capacity 2,000 cfm.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

It's a fact . . . our handy Readers' Service card is the easy way to get new catalogs.

lations, orders, delegations of authority, and forms issued pursuant to the Defense Production Act, together with brief abstracts of their content, citations to their publication in full in the Federal Register, and the names of the person to whom inquiries concerning each document should be directed. Subscription price is $6.00 per year. Secure from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

3. *Emergency Defense Activities* This is a handbook of all the federal agencies, whose functions are devoted to defense programs. Price 25¢. Secure from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

I further recommend that they place their name on the mailing list for the following free material:

1. *Bulletin of Commerce* This is a free publication issued weekly and can be obtained from the nearest field office of the U. S. Department of Commerce.
2. *Title 32A—National Defense, Appendix U. S. Department of Commerce —National Production Authority (NPA Regulations)* This is all the regulatory material issued by the National Production Authority. Mail request to U. S. Department of Commerce, Division of Printing Services, Attention: E. E. Vivian, Room 6225, Washington 25, D. C.

This material will be of great value to the official and will simplify the necessary reading and will also keep him currently informed.

We in Milwaukee have found that the local office in Milwaukee has been very willing to help us with our problems and the officials should not hesitate to contact their nearest field office.

Gil Guetzkow,
Dir. of Priorities & Allocations,
City of Milwaukee, Wisc.

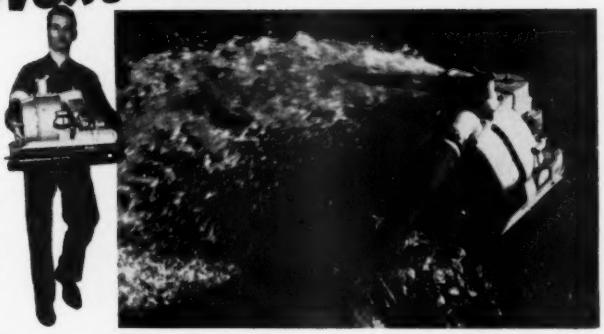
BOOKS IN BRIEF

HIGHWAY RESEARCH

The Proceedings of the 13th annual meeting of the Highway Research Board, which was held in

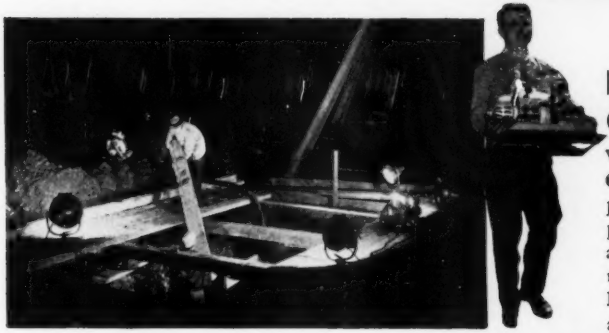
(*Please turn to page* 26)

Include HOMELITE SAVINGS *In Your Next Year's Budget*



HOMELITE
Pumps Save Money

They're easier to get on the job . . . quicker to get into operation . . . faster in pumping out water. Fastest self-priming. 28 foot suction lift. Handles up to 15,000 gallons per hour. Keeps seepage at strainer level automatically. Non clogging. Troubleproof. Weatherproof.



HOMELITE
Generators Save Money

With a Homelite Gasoline Engine Driven Generator, you always have electric power handy any place . . . instant, steady power to operate floodlights . . . to operate standard universal electric tools or the newer high cycle tools. On the job, a Homelite soon pays for itself in the time and work it saves.

HOMELITE
Chain Saws Save Money

One man with a Homelite Gasoline Chain Saw can do the work of two men in far less time. Weighing only 27 lbs. complete with *4 horsepower engine,* a Homelite is easier to handle, cuts much faster, and needs less downtime . . . less maintenance than any other saw.

Write today for complete information on Homelite Carryable Pumps, Generators and Chain Saws.

Manufacturers of Homelite
Carryable Pumps • Generators
Blowers • Chain Saws

PERFORMANCE · DEPENDABILITY · SERVICE

HOMELITE
CORPORATION

2112 RIVERDALE AVENUE • PORT CHESTER, N. Y.

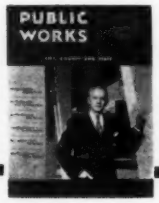
Get full details of this month's new products . . . mail your Readers' Service card today.

Preferred power for sand and material spreaders and a wide range of other equipment for road maintenance and construction — the world's most widely used single-cylinder gasoline engine on machines, tools, appliances used by industry, railroads, oil-fields, and on equipment for farm and home.

BRIGGS & STRATTON is the world's largest builder — more than 30 years of continuous production — of single-cylinder, 4-cycle, air-cooled gasoline engines. Briggs & Stratton Corporation, Milwaukee 1, Wisconsin, U.S.A.

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

Need more facts about advertised products? Mail your Readers' Service card now.



LEADERS IN THE PUBLIC WORKS FIELD

★

Dean Edward R. Stapley of the Oklahoma Institute of Technology of Oklahoma A & M College, Stillwater, Okla., is shown on our front cover standing on the Starlite Terrace of the Student Union Buildings of the A & M Campus. Outstanding in his profession, Dean Stapley progressed from a farm boy in a one-room country school to Cornell, where he received bachelor's and master's degrees in civil engineering, and to Harvard, where he received a degree in sanitary engineering. He left Cornell in 1916 and served as an assistant city engineer, with a consulting engineer, as an Army officer in World War I and in other engineering work. He came to Oklahoma in 1925.

In his 26 years at A & M, Dean Stapley has risen from Associate Professor to his present position. His energy and tireless enthusiasm has been evident in resident and extension teaching, technical writing, consulting engineering and public service of many kinds. He is a member of more professional societies than we have room to list here; nor can we tell of the many activities in which he is engaged. Perhaps, however, we can sum it all up with a single statement: "Mighty fine man."

BOOKS (Cont.)

Washington, D. C., in January, 1951, are now available. Papers and articles are grouped under: Traffic and operations; soils; maintenance; materials and construction; design; and economics, finance and administration. 527 pages. Highway Research Board, Washington 25, D. C. $7.50.

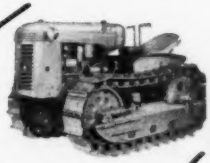
OLIVER

the "CHOICE" Line

When performance under exacting operating conditions . . . where dependability and low operating and maintenance expense are essential, the *choice* of cost-conscious operators is Oliver. Your Oliver Industrial Distributor will be happy to give you all the facts on why this complete line of job-speeding wheel and crawler tractors and matched allied equipment should be *your* choice! The Oliver Corporation, Industrial Division, 19300 Euclid Ave., Cleveland 17, Ohio.

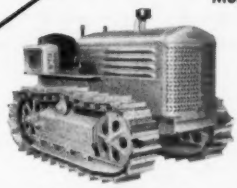
Model "88"—45 h.p. Gas or Diesel

Model "77"—39 h.p. Gas

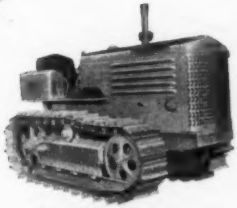


Model OC-3—22 h.p. Gas

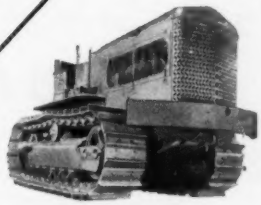
Model "66"—27 h.p. Gas



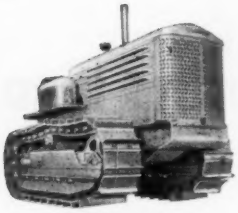
Model A—30.5 h.p. Gas or Diesel



Model B—38 h.p. Gas or Diesel



Model FDE—110 h.p. Diesel



Model D—61 h.p. Gas or Diesel

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A complete line of industrial wheel and crawler tractors

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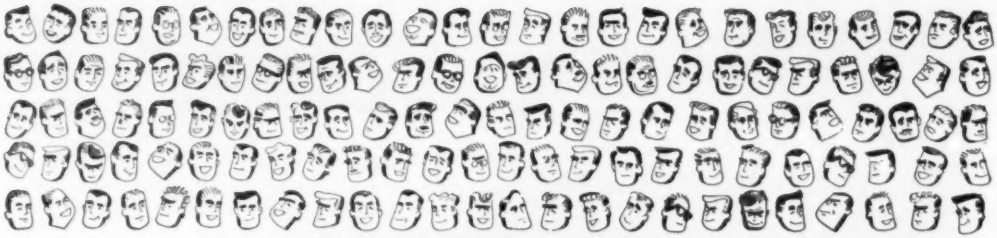
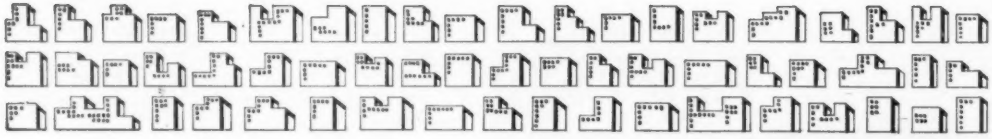
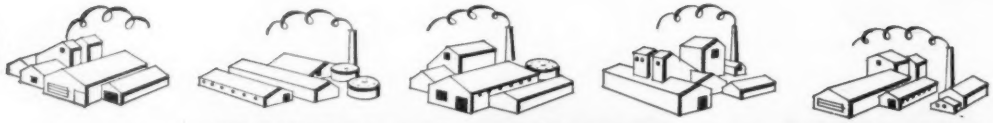


257 FIELD REPRESENTATIVES

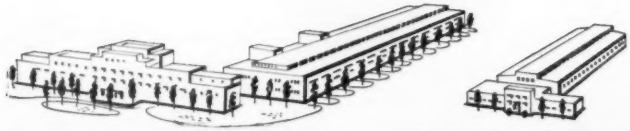
48 INSTALLATION INSTRUCTORS



58 SALES OFFICES



5 MANUFACTURING LOCATIONS



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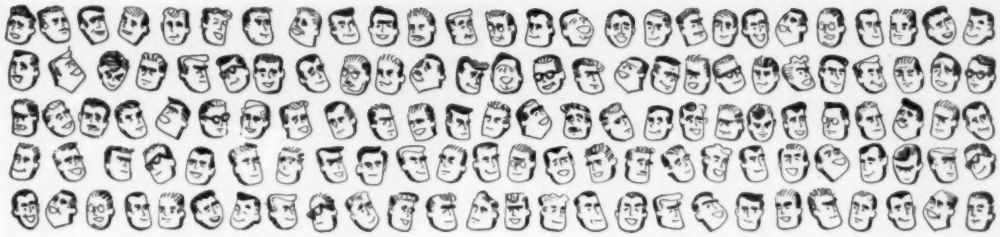

At your service—

. . . a complete, nationwide TRANSITE PIPE ORGANIZATION

Here is an organization which, over the past many years, has helped to bring a better, a more efficient and a more economical means of water transportation to many hundreds of American cities and towns.

Its facilities include more than 250 field representatives with headquarters in 58 cities. It also comprises a staff of competent installation instructors who explain recommended installation practices to pipe-laying crews. This Johns-Manville service is an important factor in helping to assure the installation economies as well as the long-term *overall* economies that go with Transite Pressure Pipe.

Behind this field organization are the modern production methods which assure the high quality of the finished product. These begin with careful selection of raw materials and are continued through the special processing operations to the final tests which each individual length of pipe must undergo before shipment is made. Five conveniently located plants now serve Transite Pipe users from coast to coast.

And back of all this is engineering—and research. For without them, the plus values that have been built into Transite Pipe would not have been possible. Today, in the new J-M Research Center, the engineer and the technician continue to find new answers to old problems. Their work is an indispensable part of the complete Transite Pipe service which Johns-Manville offers the water works industry. For further information, write Johns-Manville, Box 290, New York 16, N. Y.

*TRANSITE is a Johns-Manville registered trade mark

TRANSITE ASBESTOS-CEMENT PRESSURE PIPE

FOR BETTER WATER SERVICE

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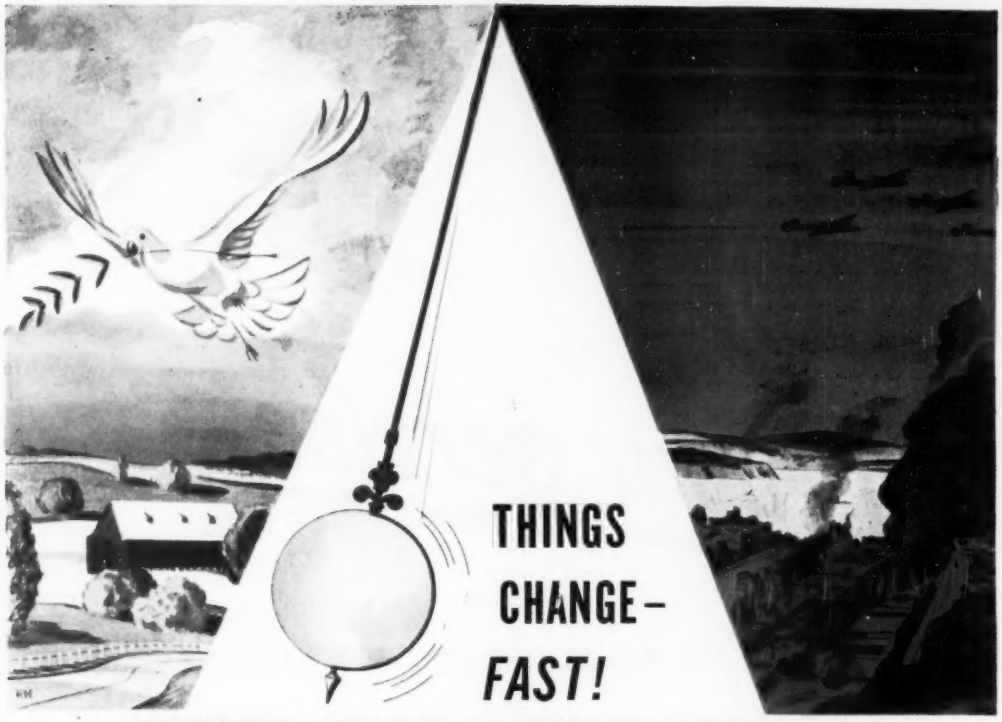

WOULD YOUR CITY BE READY?

We all fervently hope you will never need to use an air-raid warning system in your community; but what if the international picture changed overnight? Could you get a warning system up in time? Would it do the job? Could you train your population in its meaning?

You can resolve these vital questions now by calling in your Federal representative. He can help you scientifically plan a warning system for your specific needs and at far more reasonable cost than a rushed, makeshift system you'd have to buy at a premium. He can show you how you can coordinate your activities with the government Civil Defense program and its available funds for municipalities.

For you must plan now! Federal will show you how a multiple small siren system will give you 20% greater warning coverage than centrally-located large signals. Federal signals are the world's finest and loudest and are now installed in planned systems that protect many cities. Don't underestimate the necessity of being ready to save your city's population . . . discuss this vital problem with your Federal representative this week!

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FORMERLY: FEDERAL ELECTRIC COMPANY, INC.

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Get full details of this month's new products . . . mail your Readers' Service card today.

DO IT ELECTRICALLY
with the NEW "111"

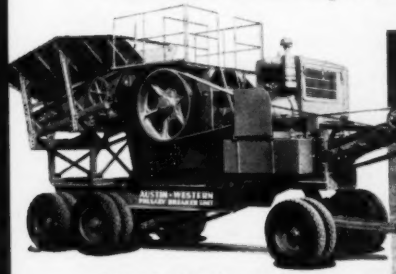
Production is higher
Upkeep is lower
Push Buttons do the work

Michigan Gravel

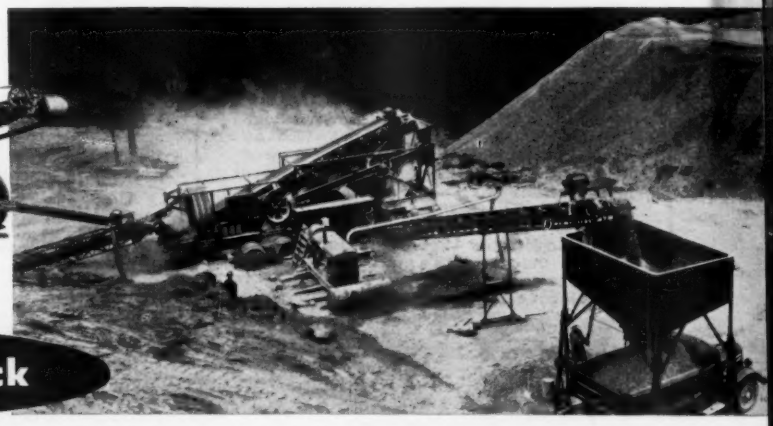
Production is higher—because each unit has its own electric motor drive; thus operates at top speed and efficiency at all times.

Upkeep is lower—because drives are simple and have few parts.

Push buttons do the work—the man on the platform starts and stops the feed and delivery conveyors, and has other units under complete control.



Primary Breaker units are made in several sizes; this one has a 3' x 10' apron feeder, 20" x 36" jaw crusher, power unit and delivery conveyor—all mounted on pneumatic tires.



Carolina Rock

The high production "111," with its 10" x 36" jaw and 40" x 24" roll crushers, is equally at home in gravel and rock. On this quarry job, production is still further increased by using a Primary Breaker unit with 32" x 40" jaw crusher (not visible in the photograph) to reduce the oversize to about 5 inches.

AUSTIN-WESTERN COMPANY · *Subsidiary of Baldwin-Lima-Hamilton Corporation* · **AURORA, ILLINOIS, U.S.A.**

BALDWIN BLH LIMA-HAMILTON

Austin-Western

SINCE 1859—BUILDERS OF CONSTRUCTION EQUIPMENT

HIGHWAYS, STREETS AND ROADS NEED THE LITTLEFORD 84-HD KETTLE

TIME SAVER

84-HD Kettle using Hand Spray Attachment for Patch Work.

COST SAVER

When the Littleford 84-HD Kettle is on a road maintenance job its faster heating, efficiency in operation and patented features make it a Time Saver, Cost Saver and Road Saver. No other Kettle has ever been designed with such painstaking effort as the 84-HD. This Littleford unit has patented features such as Double Heat Circulation System, which utilizes the entire heat of the Burner, and Screened Reservoir, which assures a continuous flow of hot materials even when cold materials are added during the heating. These features are the reason why the 84-HD has repaired more Roads, Streets and Highways than any other kettle on the market. To make the 84-HD even more efficient, a Hand Spray or Motor Spray Attachment can be added to this Kettle.

ROAD SAVER

For further details see your nearest Littleford Equipment Distributor.

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BLACK TOP ROAD MAINTENANCE EQUIPMENT LB SINCE - 1900 LITTLEFORD

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452 E. Pearl St., Cincinnati 2, Ohio

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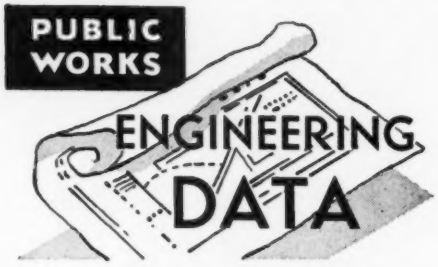

Comparative Costs of Water Works items—1948 to 1951

The following data have been furnished us by Henry J. Graeser, Ass't. Supt., Dallas, Texas Water Department. Karl R. Hofle is Superintendent. The table shows the cost of materials frequently used by the Department for the year 1948 to 1951 inclusive.

Item	1948	1949	1950	1951
6″ 45° Concrete Curves	.65	.65	.70	.87
6″ 45° Tile Curves	.46	.49	.49	.52
8″ x 6″ Concrete Wyes	1.37	1.48	1.48	1.65
8″ x 6″ Tile Wyes	1.78	1.85	1.85	2.18
¾″ Corp. Cocks	.98	—	1.20	1.45
1″ Corp. Cocks	—	—	1.66	2.38
1½″ Corp. Cocks	3.80	—	4.12	5.78
2″ Corp. Cocks	6.32	—	5.29	10.17
Pig Lead	.19	.21	.13	.20
¾″ Brass Couplings	.32	.32	.42	.53
1″ Brass Couplings	.44	—	.41	.70
¾″ Copper Pipe	.24	.23	.27	.31
1″ Copper Pipe	.33	—	.33	.38
1½″ Copper Pipe	.49	.45	.53	.78
2″ Copper Pipe	.72	.65	.78	.90
1½″ Brass Wheel Valves	4.23	4.45	3.92	5.67
2″ Brass Wheel Valves	6.00	6.30	6.50	8.04
2″ H. E. Gate Valves	—	—	13.03	17.53
4″ H. E. Gate Valves	22.20	—	21.41	28.01
6″ H. E. Gate Valves	34.26	35.43	—	44.83
8″ H. E. Gate Valves	52.97	—	—	69.39
10″ H. E. Gate Valves	—	99.08	—	—
12″ H. E. Gate Valves	119.34	—	—	152.15
16″ H. E. Gate Valves	356.45	284.00	256.96	349.71
5″ Fire Hydrants	—	93.10	93.10	103.00

● ● ●

Cement Lining Mains to Increase Carrying Capacity

Engineering studies on the mains of the La Mesa, Lemon Grove and Spring Valley Irrigation District, one of the water using authorities of San Diego Co., Calif., were made in 1949 and 1950. These studies indicated that some of these water lines had, in addition to a high leakage record, excessive friction losses which reduced substantially their carrying capacity and, in the case of force lines, resulted in a high pumping cost.

It was determined that a cement lining in these mains would eliminate these problems and would be far more economical than replacing the lines with new pipe. A contract was made with the American Pipe and Construction Co. to apply the Centriline process to about 4,100 ft. of 18-inch line, at a cost of $14,751. It is estimated that this treatment will re-

(*Please turn to page* 36)

Don't worry about pipe diameter!

DRESSER STYLE 82 SLEEVES MAKE TIGHT, PERMANENT REPAIRS ON ANY CLASS OF CIP

No need to let off-size pipe hold up your repair when every minute counts. The Dresser Style 82 Adjustable Repair Sleeve, with its interchangeable sections, has an adjustment range sufficient to provide a close fit on all classes of cast iron pipe—A through D.

Measuring tape supplied with sleeve indicates the proper combination of sections. Gaskets come already positioned; no trimming or fitting. One man with a wrench can make a permanent, bottle-tight repair in 10 minutes or less. Furnished for 4", 6" and 8" CIP. Also ideal as tapping sleeve.

Write today for literature and prices.

Dresser Style 82 Sleeve being installed over break. Note that nuts on all bolts are at the top—easy to tighten.

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"ADJUSTABLE"
SLEEVES

Dresser Manufacturing Division, 59 Fisher Ave., Bradford, Pa. (One of the Dresser Industries) — In Texas: 1121 Rothwell St., Houston — In Canada: Dresser Mfg. Co., Ltd., 629 Adelaide St., W., Toronto — Sales Offices: New York, Philadelphia, Chicago, Houston, San Francisco.

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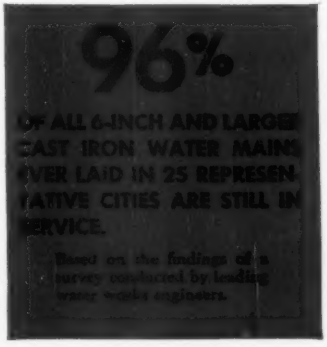
A "Grand National" Winner... like Cast Iron Pipe...has

The Grand National Steeplechase, over a course of about 4½ miles with 30 jumps, is a rugged test of the *stamina* of a horse. Likewise, the test of time proves the *stamina* of cast iron pipe. For example, in more than 30 of the older American cities, cast iron water and gas mains are now in their second century of service. These sturdy mains are meeting changed conditions undreamed-of 100 years ago—in street traffic and in construction aboveground and underground. The resultant traffic shock and beam-stresses, cast iron pipe has taken in its stride, because of its shock-strength, beam-strength and crushing-strength.

No pipe, deficient in any of these strength-factors of long life, should ever be laid in paved streets of cities, towns and villages.


96%
OF ALL 6-INCH AND LARGER CAST IRON WATER MAINS EVER LAID IN 25 REPRESENTATIVE CITIES ARE STILL IN SERVICE.
Based on the findings of a survey conducted by leading water works engineers.

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STAMINA!*

* First run in England 112 years ago, the Grand National Steeplechase, over the famous Aintree course of 4 miles, 856 yards, was won in the record time of 9.20-2/5 by Golden Miller in 1934.

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70% Faster with
TILDEN ROTARY KONKRETE KORE DRILLS

Why? *Only Tilden has this patented slot . . . expels cuttings automatically!*

- Diameters 3/16" to 4" in stock
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- Quiet operation - no hammer

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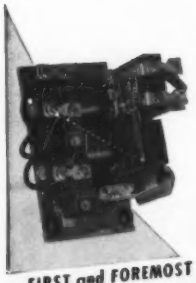
SOLD BY BETTER SUPPLY HOUSES EVERYWHERE

B W *All Electric Floatless...*
LIQUID LEVEL CONTROLS



Control variations in levels from ¼" upward. Remote control if desired — any distance. Controls unaffected by acids, caustics, pressures or temperatures.

Since 1933 B/W Controls have provided positive, dependable, economical liquid level control. No floats! No vacuum tubes! No moving parts in liquid.

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B/W CONTROLLER CORPORATION
2224 E. Maple Road
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FIRST and FOREMOST IN THE FLOATLESS CONTROL FIELD

sult in annual savings of $2,275 in power consumption, elimination of leak repairs and damage claims. Additional contracts were let later amounting to $10,784 and $16,862 for other lines. Similar benefits are expected in cost reductions on these lines.

• • •

Bid Prices on Large Sewers

Bids were opened July 24, 1951, by the City and County of Denver, Colo., for the construction of the Northeast Storm Sewer. The three low bidders were: (1) Thos. Bate & Sons, to whom the contract was awarded; (2) Birchby & Nauman, Inc.; and (3) Peter Seerie, Inc., & M. J. Sears. The data were furnished us by T. G. Munroe, Office Manager, Department of Improvements & Parks of Denver. Unit bid prices for the three low bidders were:

Items	*Amount*	*(1)*	*(2)*	*(3)*
72-inch RC	7,635 LF	$27.80	$37.80	$36.67
66-inch RC	315 "	25.35	32.00	27.90
60-inch RC	1,505 "	22.20	28.00	24.70
54-inch RC	5,565 "	20.00	23.00	22.31
48-inch RC	12,480 "	15.75	16.00	17.70
42-inch RC	6,660 "	14.00	13.00	14.71
36-inch RC	4,436 "	13.00	11.00	10.47
33-inch RC	912 "	12.25	10.60	11.30
27-inch RC	340 "	10.50	8.40	10.15
24-inch RC	672 "	10.00	7.60	8.25
21-inch RC	700 "	9.75	6.90	7.00
12-in. Conc.	5,552 "	3.00	2.40	4.15

Various other items were included in the work. The contract award totalled $928,718.25; second low bidder was $1,029,184.20; and the third low was $1,048,184.52.

• • •

Cost of Laying Water Mains

The average cost of laying water mains in Kenosha, Wisc., in 1950, exclusive of fire hydrants, was as follows: For 3,188 ft. of 6-inch, the material cost was $1.98 per ft., the labor cost 80¢ per ft., and the total cost $2.78 per ft. For 314 ft. of 8-inch, the costs were $2.91 for material and $1.69 for labor, a total of $4.60 per ft. For 494 ft. of 12-inch, the costs were $3.86 for material and $1.20 for labor, a total of $5.06 per ft. These data are from the 1950 annual report.

• • •

Garbage and Ash Collection Costs

According to the excellent 1950 report of Easton, Pa., costs for garbage and rubbish collection were as follows, per ton: Labor, $5.83; trucks, 35.9¢; handling at incinerator, $1.538; fuel, 2.12¢; supervision, 27.49¢; and maintenance and operation, 15.09¢. Total collections amounted to 8,004 tons. Costs of ash collection were: Labor, $3.733; trucks, 34.44¢; and supervision, 26.36¢. Total collections amounted to 7,281 tons.

• • •

1950 Costs of Laying Water Pipe

The annual report of the Water Bureau of Hartford, Conn., gives the following costs for laying water pipes during the year 1950:

Size	Length	Labor	Material	Misc.	Total per ft.
6"	2,480 ft.	$2.198	$1.382	$0.176	$3.756
8"	41,013 "	2.517	0.805	1.038	4.360
10"	1,701 "	3.717	1.169	. . .	4.886
12"	17,747 "	4.115	0.975	1.390	6.480
16"	3,627 "	6.741	2.508	.207	9.546

The item for labor includes cartage and transportation costs.

Need more facts about advertised products? Mail your Readers' Service card now.

One of the largest (handling 30 million gallons per day) water works plants in the southwest (Phoenix) selected Jeffrey FLOCTROLS for the mixing basins — Jeffrey Sludge Collectors for the settling basins. Successful operation for several years has proved this a wise choice.

Other Jeffrey equipment installed in this plant includes: Grit Collectors; Rapid Mixers; Chemical Handling machinery such as Spiral Conveyors and Bucket Elevators.

Jeffrey also makes: Back-cleaned Screens, Grit Washers, Scum Removers, Garbage and Screenings Grinders, Chemical Feeders, Chains, etc.

CATALOG No. 833 TELLS ALL

THE JEFFREY MANUFACTURING COMPANY Established 1877

947 North Fourth St., Columbus 16, Ohio

Complete Line of Material Handling, Processing and Mining Equipment

Baltimore 2 Boston 16 Cincinnati 2 Detroit 13 Houston 2 New York 7 St. Louis 1
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Now's the time to mail this month's Readers' Service card.

They work together . . .

for best results

Yes, teamwork is pretty important when it comes to steering a big hook and ladder fire truck. And for ice and snow removal—without corrosion, SALT AND BANOX* is the unbeatable team.

Salt is clean, effective and economical, yet many communities hesitate to use salt on streets because of its rusting tendencies.

Now you can obtain the benefits of salt without corrosion. Just add one pound of Banox to each 100 pounds of salt.

Banox is the new rust inhibitor that neutralizes the corrosive effects of street slush and salt brine . . . reduces the rusting of automobiles as well as municipal equipment and structural steel . . . ends the motorist's fears and complaints of rust.

Keep your community progressive and abreast of new developments. End your winter-weather worries like countless other communities have done with the effective and economical Salt-Banox team.

Let us send you additional information on this *proven* method of controlling ice and snow.

**Trade Mark Reg. U.S. Pat. Off.*

HAGAN HALL BUROMIN CALGON

calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PA.

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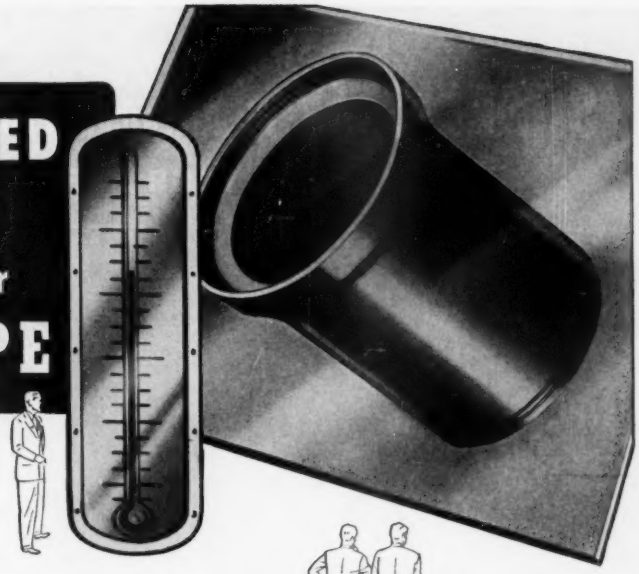
CONTROLLED DRYING Makes Your CLAY PIPE



- **STRAIGHT**
- **ROUND**
- **SMOOTH**

Nature makes Clay Pipe acid-proof and everlasting. It can't corrode, crumble, or rust away. But science works closely with nature to make Clay Pipe the engineer's top choice for every sewerage and drainage job.

Controlled drying keeps Clay Pipe uniformly straight for easier installation, round and smooth for maximum velocity. Warm air is circulated in and around the Clay Pipe, drying it evenly. Thermostats control the temperature. End result: the best pipe for your sewerage and drainage jobs.

When you specify Vitrified Clay, you're selecting the best efforts of science and nature working hand in hand. Together, they produce for you the *only* pipe that *never wears out!*

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SPECIFY *Vitrified* **CLAY PIPE**

CLAY PIPE NEVER WEARS OUT!

Seasons Greetings

AND MANY THANKS FOR YOUR CONTINUED FRIENDSHIP AND SUPPORT

. . . THE CLAY PIPE INDUSTRY

SIMPLICITY of AMERICAN FROST BOTTOM METERS

REDUCES YOUR REPAIR COSTS

There's no worry about freeze-ups of American Meters causing high repair bills. The simple patented frost bottoms break at the correct pressure to protect all other parts, because they are not affected by the tightening of the flange bolts.

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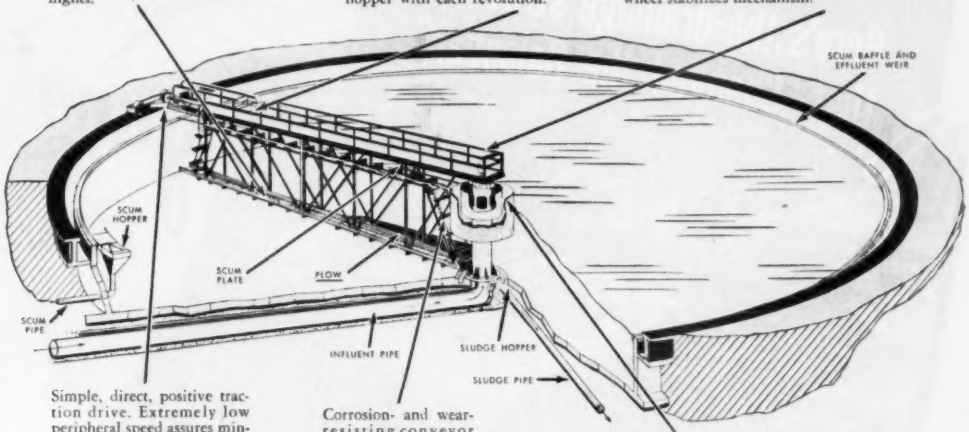
Settled sludge is collected by a plow with a brass squeegee and carried continuously to the drawoff hopper by the slow-moving conveyor with steel flights.

Floating material is carried to a trap at the outer end of the bridge by the return run of the conveyor and discharged into the scum hopper with each revolution.

Rugged bridge pivots on a large ball bearing. Outer end is mounted on a solid rubber tired traction drive wheel equipped with anti-friction bearings. Forward wheel stabilizes mechanism.



Simple, direct, positive traction drive. Extremely low peripheral speed assures minimum agitation.

Corrosion- and wear-resisting conveyor chains are Promal with a tensile strength of 70,000 lbs./sq. in.

Uniform radial distribution of influent is provided by solid and perforated baffles that dissipate the kinetic energy.

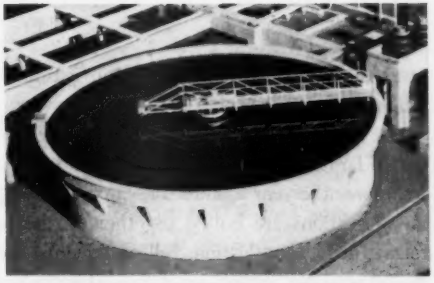
Removes all sludge from tank floor in one revolution

LINK-BELT Circuline Sludge Collector offers efficiency of Straightline Action for round settling tanks

GET quick, positive sludge and scum removal from round settling tanks with Link-Belt Circuline Sludge Collectors. Famous Straightline action provides high efficiency and greater solids concentration.

That's because maximum sludge concentration and complete sludge and scum removal are accomplished—in the shortest time—without septicity . . . without maintaining any sludge blanket.

Circuline Collectors are part of the complete Link-Belt line of quality equipment. Our sanitary engineers will be glad to work with your engineers, chemists and consultants to give you the best in modern water, sewage or industrial liquids treatment equipment.



In water, sewage and industrial liquids plants, intermittent operation (usually once or twice per day) assures high efficiency and real economy. In final tanks of activated sludge plants operation is continuous.

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12,098

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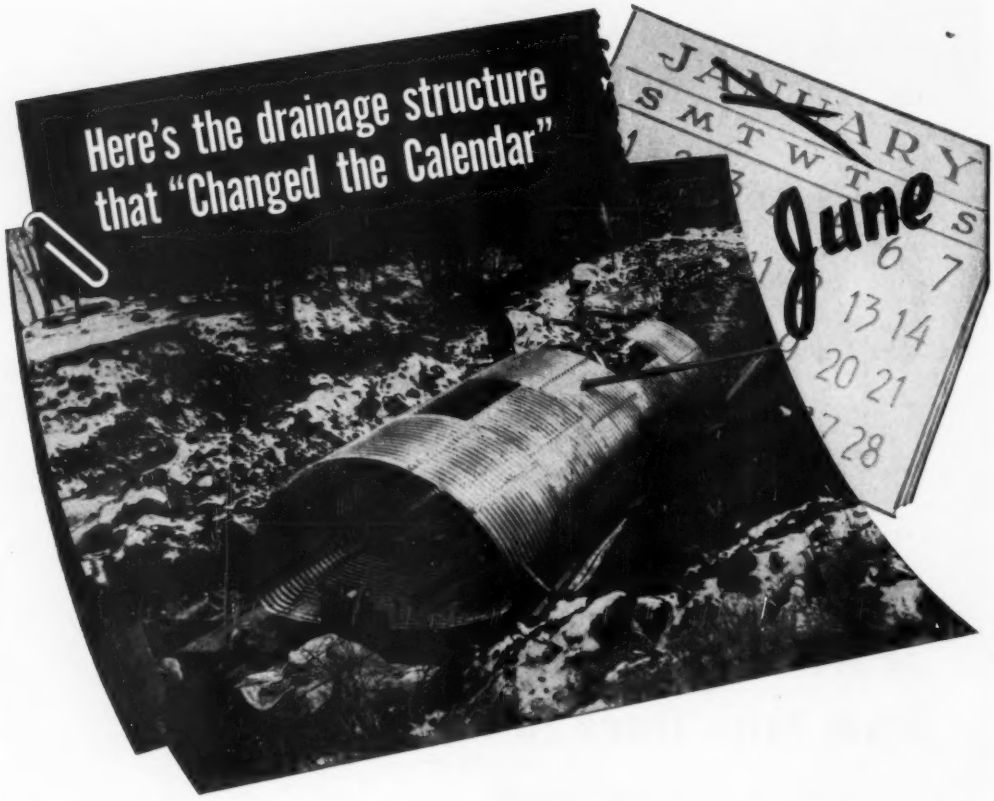

It used to be that the construction season ended when winter began.

But now, thanks to Armco MULTI-PLATE, you can install large sewers, stream enclosures and similar structures the year around. Pre-curved, corrugated metal sections are bolted together on the job to form sturdy, long lasting, full-round pipe, arch or PIPE-ARCH. No curing, no delay. The job is done quickly with a small unskilled crew. Costs are low.

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PUBLIC WORKS
Magazine
DECEMBER 1951 VOLUME 82 • NO. 12

Laying Curbs and Gutters by Machine

R. K. McGILLIVRAY,
Director of Public Works, Bay City, Mich.

OUR city purchased a curb and gutter constructing machine so as to speed up construction work and permit building more curb and gutter at less expense to the taxpayer. It has been satisfactory and its use has increased production from 15% to 20%. It has eliminated such problems as burdensome overtime pay for finishing concrete poured close to quitting time. It has also created some problems—none of them very serious.

We soon found that our workmen had to be taught the procedures of this new and better way of doing the work. Along with this came one of our first problems—the transportation of the machine across street intersections and from job to job. We experimented with a portable track for running the machine across intersections; and also with the use of a trailer. Neither method proved satisfactory. We then constructed a frame and hoist mounted on a dump truck. With this we were able to move the curb and gutter machine both across intersections and from street to street; and after moving the machine, the truck was free for other work. The curb and gutter machine can be raised and held by the extended hoist arm and we find this is helpful in cleaning the machine. It is very important to clean the machine daily.

The Concrete Mix

One of our serious difficulties was that of determining a concrete mix that would flow through the machine and would also produce a satisfactory surface. This was comparatively easy with pit-run gravel because the stone would not hit on the trowel boards. When crushed stone was used, the angular parts often caught on the top surface. This was overcome by adjusting the mix and by using air-entrained concrete, with the addition of a tamper in the front hopper of the machine. This tamper tends to settle the angular stones just below the surface, preventing them from catching on the top mold. We also learned, through experience, that if part of the coarse material was screened out from some of the ready-mix concrete and was placed in the rear hopper, the final finish was greatly improved. This can also be accomplished by using a small concrete mixer to mix fines to place in the rear hopper. The consistency of the mix is of extreme importance and particular care should be given to this phase of the operation.

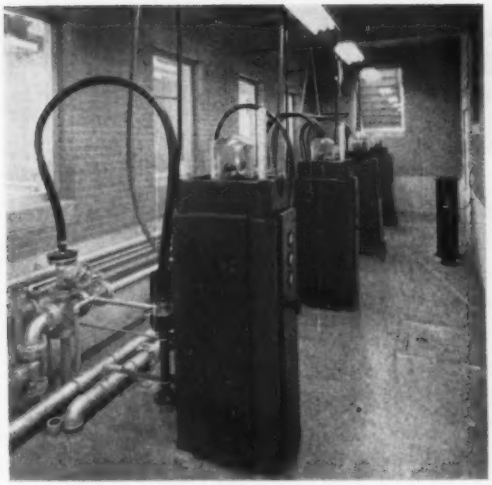
Advantages and Disadvantages

Prior to acquiring the curb and gutter machine, one of our problems was overtime to finish concrete poured just before quitting time. Overtime pay was burdensome. By using the curb and gutter machine, we found that much finish work could be eliminated because: (1) greater attention was given to the control of the wetness or dryness of the mix, so that when it was processed through the machine, it needed little further troweling; (2)

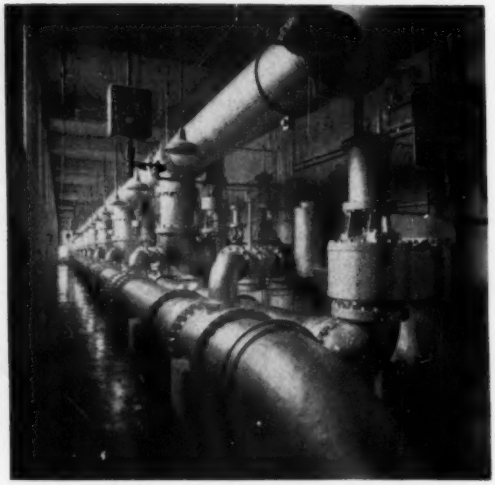
(*Continued on page* 92)

● ***BUILDS more curb and gutter at less cost.***

● ***DUMP truck and frame handles the machine.***



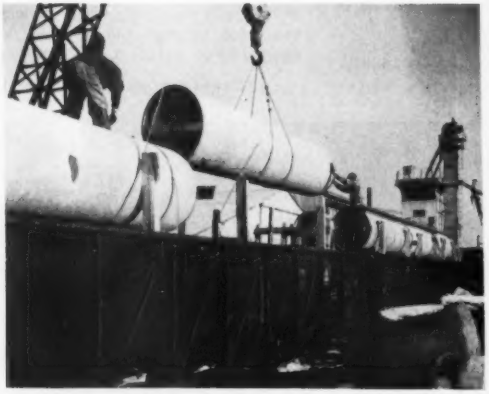
• ***INTERIOR** view of the chlorination room.*



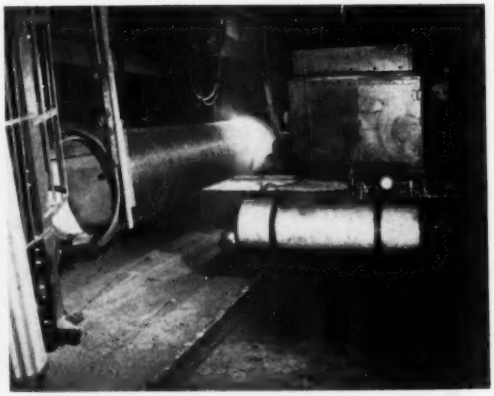
• ***INSIDE** view of pipe gallery of the plant.*

• ***LABORATORY** facilities are comprehensive.*

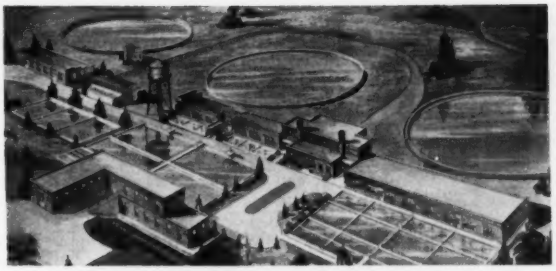
• ***FILTERS** and controls in the new plant.*



• ***LOADING** the pipe for shipment to the job.*



• ***PLACING** ¾-inch mortar coating on pipe.*



• *ARTIST'S sketch of Winston-Salem's new filter plant.*

New Water Works Facilities for WINSTON-SALEM

FRANCIS S. FRIEL

President, Albright & Friel, Inc.
Consulting Engineers

WATER for Winston-Salem, N. C., has, in the past, come from two sources, Salem Creek and Brushy Ford Creek. Both of these are of limited capacity and, due to the growth of the city and the surrounding areas and to a consequent marked increase in water usage, they have become inadequate to provide the needed quantity of water. Salem Filter Plant, on Brushy Ford Creek, could supply about 12 mgd and Salem reservoir had a storage capacity of about 1,250 mg. Winston Filter Plant had a rated capacity of 2 mgd and Winston Reservoir had a storage capacity of 125 mg.

Water use in Winston-Salem has shown a continuing increase for the past twenty-five years, with an accelerated rate of increase, quite out of proportion to the population increase, in the years 1940 to 1946. The per capita consumption rose from 91 gpd in 1921 to 95 gpd in 1940 and to 116 gpd in 1946. This was due largely to increased industrialization. The estimated safe yield of the two supplies did not exceed 10 mgd, whereas 1946 water use averaged 10.65 mgd; and in 1947 the water shortage was so serious that emergency conservation measures had to be adopted, including restrictions on use of swimming pools, lawn and other sprinkling, car washing, street flushing and use of certain types of air conditioning equipment; and it was required that all plumbing leaks be repaired immediately. Estimated total water use for the future for the city proper was 11.6 mgd for 1950, 14.0 mgd for 1960 and 16.2 mgd for 1970. If suburban areas adjacent to the city were annexed, it was estimated that the water demand would be 15.0, 17.5 and 20.0 mgd for the years mentioned above; and that peak demands would be approximately 50% above these figures.

Getting A New Supply

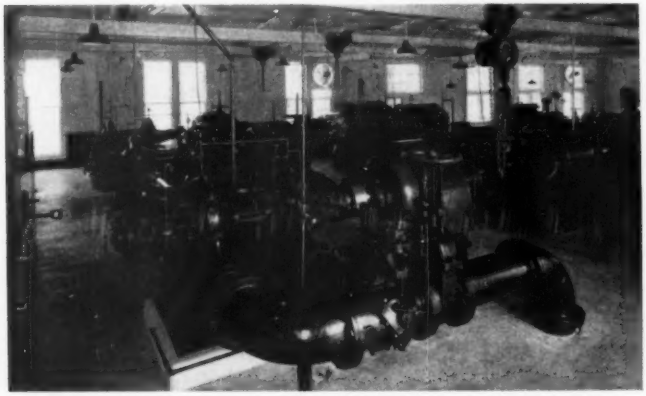
These studies indicated the necessity for a new supply with a minimum present capacity of 20 mgd during the driest year, with possibility of further development in future years. Engineering studies were made of three possible sources —The Dan River, Muddy Creek and the Yadkin River. Of these, the most suitable was the Yadkin, with water being taken from the Duke Power Company pool at Idols. Watershed area above this point is 1905 square miles and the average stream flow is 1.25 cfs per square mile. The diversion necessary to provide 20 mgd for Winston-Salem amounts to only 1.3% of the total flow. Studies indicated that neither population density (57 per square mile) nor industrial development should seriously affect the quality of the water. Samples were taken and sanitary, chemical and bacteriological analyses made covering five separate weeks and six different locations. Extensive tests were made to determine the treatability of the water. All of these tests were satisfactory.

Since the water from Salem Creek flows by gravity to the filter plant, whereas the new supply and the Winston reservoir require pumping, it was decided to utilize the Salem filter plant and pumping station to the fullest extent and to enlarge these so as to provide facilities for treating the water brought in from the Yadkin and delivering it to the city. The Winston reservoir and plant, being of small capacity, and relatively outmoded were abandoned.

The overall plan adopted provided for a pumping plant at Idols Pool to deliver water through 15,800 ft. of 36-in. Lock Joint force main to a welded steel standpipe at a higher elevation whence the water would flow by gravity to the Salem Creek filter plant. The standpipe is 20 ft. in diameter and 120 ft. high, with a capacity of 1 mg and was erected by Chicago Bridge & Iron Company. From this standpipe, which is so designed as to be capable of an extension in height of 30 ft., water flows through 57,685 ft. of 36-inch reinforced concrete pipe line to the Salem filter plant. At the filter plant, an adjustable throttling valve correlates the rate of flow from this 36-in. line to correspond approximately to the raw

water pumpage rate, thereby avoiding overflow or undesirable drawdown of the standpipe. Any excess in flow above filter plant requirements can be diverted to the Salem Reservoir through a new steel pipe line, 48-inches in diameter and 9,400 ft. long which was installed between Salem Reservoir and the filter plant to replace an old wood stave pipe line.

The pumping head at Idols Pool, at the 20 mgd rate, including suction, static and friction losses, is about 320 ft. Water surface elevation in the standpipe is about 233 ft. above the pool level and 131.75 ft. above the raw water inlet of the filter plant. Link-Belt traveling screens, with standard galvanized steel screen cloth, electrofluid drive and water spray washing, are provided ahead of the pumps at Idols Pool. Two Worthington vertical 4-bowl turbine pumps of 10 mgd capacity against a head of 320 ft. were installed. These are driven by 600-hp 3-phase motors operating at 2,300 volts. The pumps, which operate at 1,200 rpm, are protected against backflow by two emergency closing 18-inch hydraulically operated roto-valves furnished by S. Morgan Smith Company.



● ***AT THE high-level pumping station, pumping head is about 320 ft. Worthington pumps are preceded by Link-Belt screens.***

Changes at the Salem Plant

Material expansion of practically all facilities was necessary at the Salem filter plant and at the pumping station delivering filtered water to the city. Filtration and pumping capacities were increased to deliver an average of 20 mgd to the city and increased storage facilities were provided in the distribution system to handle the peak requirements that may occur when the weekly average consumption reaches the maximum of 20 mgd.

Changes include the addition of four new mixing-coagulation-settling basins; revisions of the existing basins including installation of mixing equipment; construction of eight new filters and one new filtered water basin; provision of additional pumping facilities amounting to 18 mgd; and installation of modern automatic chemical feeding facilities.

The two existing settling basins were revamped by providing a 30-inch distribution channel at the inlet end and installing three Dorr flocculators. These have a paddle periphery of 11 ft. The intermediate speeds on them are 2.71, 2.13 and 1.78 rpm; the maximum speeds are about 15% higher; and the low speeds are two-thirds of the intermediate. Peripheral velocities at intermediate speeds are 1.58, 1.23 and 1.03 ft. per second. Approximately 45 minutes of mixing and about 3¼ hours of settling are provided for the water passing through the existing basins by the new arrangement.

The new section consists of four mixing and settling basins. As in the revamped section, there are three rows of paddles; however, since the water depth is only slightly more than 8 ft., paddle diameters are 6.5 ft. Intermediate speeds are 4.38, 3.44 and 2.83 rpm, with high speed 20% greater than and low speed 75% of intermediate speeds. Peripheral velocities at intermediate speeds are 1.49, 1.17 and 0.96 fps. About 45 minutes of mixing are provided and 3¼ hours of settling in these tanks which are 37 ft. 3 inches wide, 92 ft. long and have an average depth of 13 ft. 3 ins.

There are eight new filters. Each filter is 15 ft. by 24 ft., with conventional Wheeler bottoms, and with 12 ins. of graded gravel and 30 inches of sand. There are four wash troughs to each filter; and each filter is equipped with two rotating surface wash units 11 ft. in diameter. These are operated from a takeoff line from the high pressure pumping station, a regulator reducing the pressure to about 80 lbs.

All valves on the filter connections are hydraulically operated. The controls required for each unit are mounted on operating tables furnished by Roberts Filter Manufacturing Company. These are of ebony asbestos framing and top with oak paneling on the sides, and with chrome plated hardware. On each table is mounted one indicating and recording loss of head gauge and one indicating and recording rate of flow gauge; also a Simplex observation sampler. An observation well over a 36-inch square lighted white tile bottom in the chlorine contact tank provides for observation of turbidity through about 8 ft. of water.

The effluent rate controllers on the new filters are 10-inch Simplex No. 101, Type S, fluid counterweight controls; and the old filters were equipped with the same type of controllers. Filter rates are controlled by a master control mechanism with a float well in which the water level may be varied at will and which is directly connected to each fluid counterweight. By operating a knob on the rate controller, solenoid controls admit more water to the master float well and, consequently to each fluid counterweight, or release water from the same units. When set for a 1 mgd rate per filter, this rate will be maintained until the control basin reaches El. 770.66; the control will then begin throttling, with complete shutoff at 771.1.

There are four Wallace & Tiernan chlorinators, two 2,000-lb. and two 400-lb., placed in line in one room where they may readily be observed through windows in the wall of the corridor connecting the new and old plants. There are four scales, each with cradles for two 1-ton chlorine cylinders. These scales are equipped with continuous recorders, and with an alarm to indicate a predeter-

(*Continued on page* 90)

● ***TRUCK with trailer for Flexible sewer cleaning equipment***

● ***INSERTING Flexible rods in 8-in. sewer.***

● ***POWER drive is used for root growths.***

SEWER MAINTENANCE

EQUIPMENT AND ORGANIZATION

ARTHUR L. DEMAREST

Village Engineer, South Orange, N. J.

THE basic community sewerage problem of South Orange, N. J., is not unlike that of many other American communities of similar size and character. However, it would be a rarity to find two communities requiring identical sewer maintenance service since, by the same token, it would be extremely unlikely that two communities could be found having identical factors. And some of the chief factors directly related to the sewerage maintenance problem are territorial area, population, climate, terrain, water supply, design and physical condition of sewer system, maintenance equipment used, operating personnel, available funds, and administrative procedure.

South Orange is located in the northern part of New Jersey. It has a territorial area of 2.83 square miles, predominantly residential in character, with practically no industry of any consequence, and now almost fully developed. The 1950 census figures indicate a population of 15,175.

Contained entirely within present municipal boundaries we have separate sewerage systems comprising about 50 miles of sanitary sewers ranging in size from 8 inches to 12 inches in diameter and about 23 miles of storm water sewers ranging in size from 15 inches to 72 inches diameter.

From an administrative standpoint, sanitary sewer maintenance is performed as a function of the Sewer Department while the maintenance of storm water sewers is a function of our Street Department. Both of these services operate under the general supervision of the Village Engineer.

Personnel and Procedures

Our operating personnel for sanitary sewer maintenance presently consists of a field crew of one foreman, one laborer-driver, and two laborers, all of whom devote their full time and energies to this work from the standpoint of both administration and operation.

We have approximately 480 storm water inlets which we clean by hand due to the fact that practically all of them are without sumps. The design of this type of inlet without sump was adopted many years ago for the purpose of minimizing the mosquito breeding nuisance. These inlets are cleaned twice a year and are kept free of ice and snow in the winter.

All of our sewers are regularly inspected and cleaned. The topography of the Village is such that most of our sewers have sufficient slope permitting a velocity of flow that produces a scouring effect and a tendency to be self-cleaning.

When cleaning or repair work for storm sewers are necessary the work is performed by experienced Street Department personnel when they are not preoccupied with other important duties.

Our streets are lined with an estimated ten to twelve thousand trees which constitute the source of our chief maintenance problem—roots. This was formerly a difficult and disagreeable task by hand methods using wood rods but today, with our modern sewer cleaning equipment, we are able to do this work with satisfaction and far more efficiency. We have kept ourselves abreast of recent improvements in the field of sewer cleaning equipment and over the past ten years our sewer department has become fully mechanized.

List of Major Sewer Maintenance Equipment

650 Ft. of Flexible Steel sewer rods (light & heavy).
300 Ft. wood sewer rods.
100 Ft. continuous flat steel band sewer rod on reel.
750 Ft. ⅜-inch cable.
2 All-steel winches for cable.
1 Two-wheel pneumatic-tired "Carry-all" trailer with carrying frame for transporting flexible steel rods.
1 Two-H.P. gasoline engine driven power-drive for steel sewer rods.
1 Portable gasoline engine driven electric light generating unit for night emergency work.
1 Three-H.P. gasoline engine driven power - drive for cable-operated buckets.
4 Buckets, sizes 6", 9", 11", & 15".
5 Corkscrew worms, sizes 2", 4", 6", 8", & 10".
1 Cable-operated root cutter, for 12" to 24" sewers.
1 Straight nozzle.
2 Revolving nozzles.
300 Ft. of 2½" flushing hose (in 50 ft. lengths).
1 One-ton truck for sanitary sewer maintenance.
1 Three-ton street department truck for storm sewer maintenance.

We now use flexible type steel rods routinely as standard sewer cleaning equipment. Wood rods, however, are still retained as part of our equipment and we consider them a valuable asset and they are used on special occasions as circumstances may warrant. The steel rods, including cable-operated buckets, are power driven by gasoline engine drive units. Major elements of all our equipment used for both storm water and sanitary sewers are listed above.

Our most recent experience occurred on February 21st, 1951 when a report was received that raw sewage was overflowing toilet facilities on the first floor of the New Jersey Bell Telephone Company building located on our main business thoroughfare. Investigation disclosed that the 8-inch sewer main in the street was partly obstructed and the first manhole upstream of the service connection affected was surcharged to an elevation that almost reached the manhole cover and about to overflow. The sewer is on a gradient of about 8 percent. It rained heavily starting shortly after midnight and continued nearly all day. The manhole and sewer below the service connection were also surcharged due mainly to the great volume of water entering the sewer system as a result of the heavy rains. With both manholes full of sewage the approach to removal of the obstruction would have been a hopeless task without our flexible sewer cleaning equipment. Within two hours of receiving the report that sewage was backing up the obstruction was removed under most difficult conditions and service was promptly restored.

The taxpayers of our community are accustomed to high-grade sanitary service, they look only for results, and we believe they are entitled to it. The sanitary and efficient disposal of sewage is a perpetual problem that demands the constant attention of those who are charged with this responsibility.

Highway Construction Costs

RICHARD H. WILSON
Assistant State Highway Engineer

HENRY C. McCARTY
Office Engineer

RICHARD R. NORTON
Assistant Office Engineer
Division of Highways, California

THE past 15 months have shown the most rapid increase in highway construction costs in California that has occurred since 1940.

The cost of state highway construction in California has increased 22.3 percent in the first half of this year and 48.9 percent during the past 15 months.

From the California index there is no indication that this upward trend will not continue in the future. However, there are two other indexes that show a leveling off in the last several months. The Bureau of Labor Statistics Wholesale Price Index showed no increase from February to May, 1951, after rising 20.1 percent in the preceding 10 months. The Engineering News-Record Construction Cost Index showed only a 1 percent increase from February to June, 1951, after a 10.7 percent rise in the preceding year.

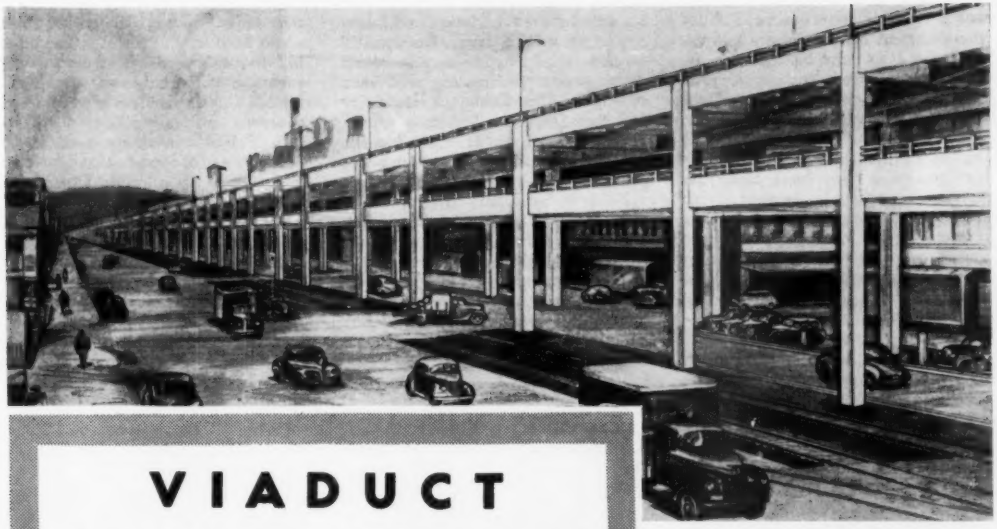
From the trend indicated by those other indexes and a general knowledge that an oversupply of many consumers goods now exists, it may be reasonable to expect that a peak in the California Highway Construction Cost Index has been reached and will level off in the near future.

Highway costs, as measured by the California Highway Construction Cost Index with the year 1940 taken as a base of 100, climbed during World War II and the post-war period to a peak of 216.8 in the first half of 1948. After 1948 there was a decline to 160 in the first quarter of 1950. From this point on there has been a very rapid rise. The second quarter of 1950 was 12.5 percent above the first quarter of 1950; the third quarter was 5.1 percent above the second quarter; the fourth quarter was 3 percent above the third quarter; the first quarter of 1951 was 10.6 percent above the fourth quarter of 1950, and the index reached 238.3 in the second quarter of 1951, which was 10.6 percent above the first quarter.

The table herewith shows the Index variations since the post-war peak in 1948. Data are from California Highways and Public Works.

Table I.—California Highway Construction Cost Index

Period	*Index 1940=100*	*Change from previous period*	*Change from first half 1948*	*Change from first quarter 1950*
1948 (first half)	*216.8*	...	...	...
1948 (second half)	*216.4*	— 0.2%	— 0.2%	...
1949 (first quarter)	*200.4*	— 7.3	— 7.6	...
1949 (second quarter)	*195.7*	— 2.3	— 9.7	...
1949 (third quarter)	*187.9*	— 4.0	—13.3	...
1949 (fourth quarter)	*178.8*	— 4.8	—17.5	...
1950 (first quarter)	*160.0*	—10.5	—26.2	...
1950 (second quarter)	*180.0*	+12.5	—17.0	+12.5%
1950 (third quarter)	*189.2*	+ 5.1	—12.7	+18.3
1950 (fourth quarter)	*194.8*	+ 3.0	—10.1	+21.8
1951 (first quarter)	*215.4*	+10.6	— 0.6	+34.6
1951 (second quarter)	*238.3*	+10.6	+ 9.9	+48.9



VIADUCT CONSTRUCTION Poses Many Problems

• ***HOW the double-deck Alaskan Way Viaduct will look when it is completed in August, 1952.***

W. A. PERINE

SCHEDULED for completion in August 1952, the $10,000,000 Alaskan Way Viaduct along Seattle's waterfront has already provided some interesting problems for R. W. Finke, City Engineer and designer of this public works project, his staff, and for the contractors who are doing the work.

The viaduct involves 2.43 miles of construction. It is the largest reinforced concrete job in the Seattle Engineering Department's history and is financed jointly by the City, the State and the Federal government. Of the $10,000,000 cost, Seattle is furnishing $4,800,000; Washington State, $1,100,000; and Federal Government $4,100,000.

The viaduct will serve three important purposes. It will provide an expressway for north-south through traffic, connecting as it does with the main arterials that lead to the north and south U. S. highway entrances to Seattle. It will also provide a traffic bypass around the business section for the large part of Seattle's population living in the north end of the city and working in the industrial district, which lies south of the business section. The present traffic jams in the business section due to the flow of cars to and from work will be practically eliminated. And it will take traffic off Alaskan Way, giving the many commercial vehicles, who have business at the docks and business firms along the waterfront, a chance to speed up their hauls.

The project begins at the southern end of Aurora Avenue with a vehicular tunnel running under Battery Street to the waterfront and onto the viaduct. The viaduct then follows the waterfront south, above Alaskan Way, to Railroad Way where it connects with First Avenue South, completely bypassing the business part of Seattle.

Five contracts are involved in the viaduct job. They are for construction of the Battery Street vehicular tunnel; the Western Avenue and Battery to Pike Street unit; the Pike to King Street unit; the south section from King to First Avenue South; and the contract for the electrical work.

The first contract awarded was for the Battery to Pike Street section which contained the north approaches to the viaduct. After a delay due to an error in a bid form that necessitated a period of waiting until a court hearing was held, this contract went to MacRae Brothers of Seattle on a bid of $1,193,911. Then extreme cold weather (January, 1950) held up the start of work for about a month.

Demolition Delays

Work started February 6, 1950, on preparation of the site. The approaches and the viaduct from the north run right through a business section and it was necessary to remove business, apartment and dwelling buildings. Some of these contested the vacation proceedings and another delay seemingly resulted when the OPA gave them 60 days to vacate after being served with notice.

However, MacRae Brothers moved a Lorain mobile crane, converted to a hoe type shovel, onto the job and performed the excavation work for building the main abutment while waiting for the buildings to be vacated. Excavation work on foundations; footings and their construction; columns; beams and girders

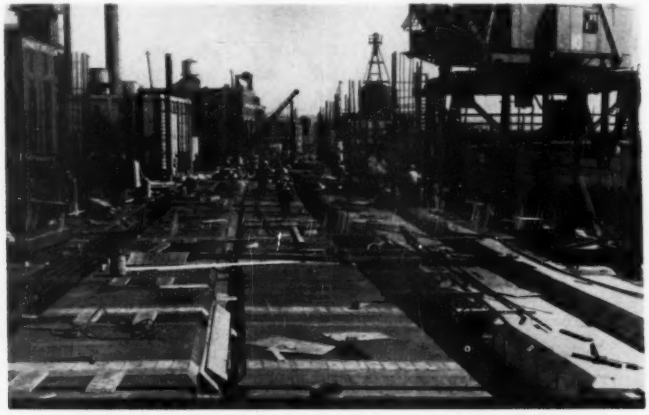
was then done from the main abutment to Bent No. 6 where a yet-to-be-vacated building barred the way. This was skipped and work proceeded from Bent No. 12 with Bent Nos. 6 to 12 being completed later.

Access to the right-of-way was limited by the Great Northern railway tracks, a steep bank along the right-of-way and several city streets and large buildings. This limitation was overcome, to some extent, by constructing intermittent sections of the viaduct, being careful not to shut off access to succeeding sections. This permitted several sections of the viaduct to be built at one time, helped in bringing in equipment and materials and gave for driving the foundation and falsework piles; two large Diamond T flatbed trucks and several Ford dump trucks for hauling materials; a small Allis-Chalmers bulldozer and two Diamond T flatbed trucks, equipped with short crane booms, for carrying materials around the job site.

Pioneer Sand and Gravel Company of Seattle furnished all the concrete for the first unit, mixing it in a central plant and delivering it in agitator trucks to the job. Diamond brand type 2 cement and aggregates from the Pioneer Steilacoom quarry were used to make the concrete. Structural steel was fabricated and furnished by the tion about August 1952, will require about 5100 linear feet of sewer pipe, 10,378 cubic yards of structure excavation, 35,154 cubic yards of concrete, 15,609 linear feet of reinforced concrete bridge railing, 9,873,000 lbs. of steel reinforcing bars, 85,000 linear feet of steel piling, 40,400 linear feet of reinforced concrete piling, 33,500 lbs. of structural steel and 62,000 lbs. of galvanized steel.

The viaduct is of 3-span, rigid frame construction, designed for Zone II earthquake load. In 1½ miles of the viaduct there is no duplication of 3-span units. Each 3-span unit includes intermediate bents and two end bents. An open joint, 1½-in. wide, separates adja-

● ***PLACING prefabricated cage.***



● ***DECK forms of 5/8-in. plywood are reused 5 to 6 times.***

the concrete time to cure.

MacRae Brothers finished the 0.43 mile of construction of the first unit of the viaduct on July 26, 1951. Final work on the job included the construction of the bridge railing. It was cast in place with steel forms built for this purpose. These did not work out too well due to the difficulty in making adjustments for line and grade. Wood forms were found not too practical due to the heavy bracing necessary and the resultant lack of sufficient clearance for finishing the top of the lower rail beam.

Equipment and Materials

Equipment used in the first unit by MacRae Brothers included several Lorain mobile cranes, converted to hoe type shovels or to clam shells for excavation work and to cranes with various length booms for hoisting work; two skid type piledrivers with No. 1 Vulcan steam hammers Pacific Car and Foundry Company of Seattle and steel reinforcing bars were furnished by Bethlehem Pacific Coast Steel Company of Seattle.

During the period of initial set, fine cracks formed in the finished Class "A" concrete roadway slab. Changes in the mix and the thickness of the slab were made. A concrete mix of six sacks of cement per cubic yard of concrete was found to be much better than the 6½-sack.

The second unit contract, now under construction, was awarded to Morrison-Knudsen Company, Inc., and Rumsey and Company jointly on a bid of $3,691,400. This section, 0.77 mile long, will be a double deck reinforced concrete expressway from Pike Street to King Street. Each deck will provide a 40-ft. clear width for traffic permitting three lanes in each direction, southbound on the lower and northbound on the upper deck.

This unit, scheduled for completion about August 1952, will require about 5100 linear feet of sewer pipe, 10,378 cubic yards of structure excavation, 35,154 cubic yards of concrete, 15,609 linear feet of reinforced concrete bridge railing, 9,873,000 lbs. of steel reinforcing bars, 85,000 linear feet of steel piling, 40,400 linear feet of reinforced concrete piling, 33,500 lbs. of structural steel and 62,000 lbs. of galvanized steel.

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Columns are 4-ft. x 5-ft. and are spread to accommodate the lower deck and provide a clear roadway. Adoption of 14-ft. curb lanes and a 12-ft. center lane with a 1½-ft. curb, brings the distance between columns to 43 feet, making heavy reinforcing necessary. Main girders span the roadways from center to center of the columns. The girders are about 7 ft. deep by 2½ ft. wide, allowing room for three layers of reinforcing bars with four 2-in. square bars in each layer. Reinforcing at the base of the columns includes thirty-eight 2-in. square bars.

Reinforcing was even heavier where there was widening for future connecting ramps, with a 12-ft. acceleration or deceleration lane, making the width between columns 55-ft.

The south section of the viaduct from King Street down to First Avenue South, 0.43 mile long, and

the Battery Street subway at the north end, 0.80 mile long, are being contracted for so as to finish along with the second step next August. The electrical contract will be the last job with the electric and telephone wires (now on poles on Alaskan Way) being suspended on the underside of the Viaduct in enclosed conduits.

Problems in Construction

Problems facing the engineers and contractors in building the Seattle viaduct were many. The steady flow of vital commercial traffic along the Alaskan Way waterfront and the many connecting streets had to be kept going. The railroad right-of-way had to be left open for trains to use. The viaduct had to be built around and even over buildings without damaging them. Access to all the commission houses, markets, fish businesses and marine firms on the waterfront had to be left open, including the railroad spurs to the firms and the dock warehouses. And finally, these restrictions limited the contractor's operations to the viaduct right-of-way with even this working space being denied at certain points of the job.

The north-south highway traffic and the commercial traffic were crowded into the paved roadway along Seattle's harbor line. Some cross streets were closed for a few hours at a time while construction work went on. Whirleys (revolving gantry cranes) were used. One main track was abandoned by agreement with the railroads and the other kept open by running it between the whirley tracks and under the whirleys. On the east side of the viaduct, track spurs and freight truck access streets were kept clear for the business houses.

In the second unit, the first 500 feet brought plenty of trouble. The railroad tracks crossed under this section and had to be kept open for through traffic while the viaduct was built over them. Falsework bents with piles capped by H beams were used to support the viaduct over the track.

In this same section the two roadways of the viaduct came together in a double deck structure and the upper deck crossed the top of a building. The building could not be used for supporting the viaduct structure while constructing it, and the building entrances and traffic access routes had to be kept clear. Plate girders, 39½ ins. deep and 56 ft. 10 in. long, were finally used to carry the construction load over the building.

The two levels meeting in one structure at this point necessitated complicated falsework framing of nine piles and three bents instead of the usual falsework piles and two false bents. Falsework was built on the first desk to support the second's construction.

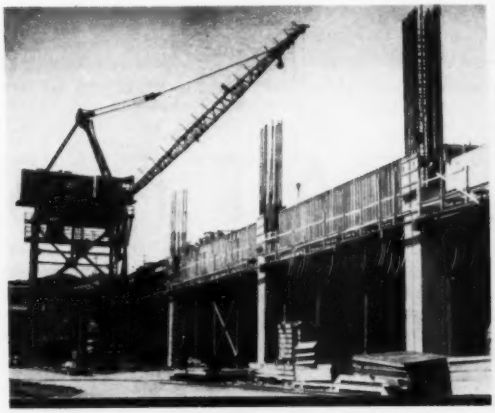
The viaduct passed over three overpasses on Alaskan Way. Two carried auto traffic and were kept open by careful planning and construction. The third at Marion Street was a pedestrian crossing. This pedestrian crossing, a 180-ft. span, was removed and altered in a steel fabricating plant and then put back as a permanent part of the Alaskan Way viaduct structure.

The waterfront bed for the viaduct structure is made up of filled-in land claimed from Puget Sound. In the fill are some buried trestles. Both Raymond cast-in-place concrete piles and steel H-piles are used for the foundations of the bents. The steel piles are used over buried trestles as they can penetrate the old structures. They vary from 52-ft. to 70-ft. in length. The concrete piles are from 20-ft. to 52-ft. long.

After the pile driving is finished, the concrete footings and sections of columns for the lower roadway are put in. Falsework, beams, girders and deck slab for the lower level of the viaduct follow. Then the columns are finished to the upper level and work is begun on it.

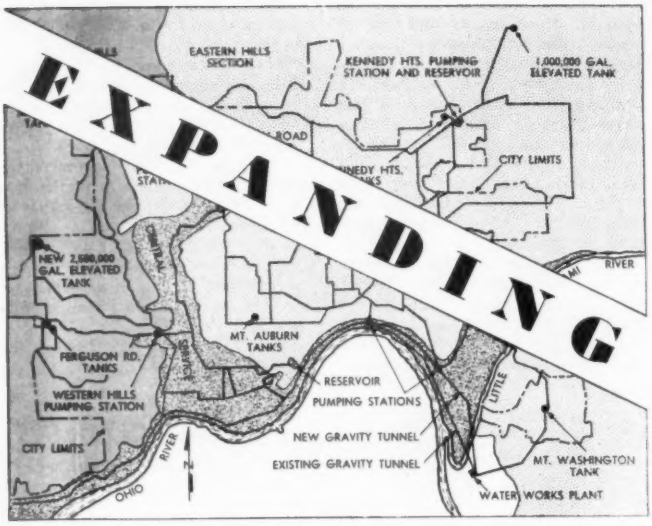
The lack of working space on the ground made it necessary to prefabricate as much of the construction material as possible. Prefabricated falsework was used. Reinforced cages for the columns were pre-assembled and brought in on flat bed trucks and lowered and lifted into place. It was found necessary to guy these cages from four directions to keep them in correct placement before they were made into columns.

Technical information for this article was obtained through the cooperation of R. W. Finke, City Engineer; H. W. Tyler, Principal Design Engineer; C. A. Pilon, State resident engineer in charge of immediate construction of the project; and Morrison-Knudson Co., Inc., contractors. Pictures are by John Bossart, Seattle City Engineer's Department.



● ***WHIRLEY placing deck forms and side panels.***

● ***POURING footings; 2-in. steel cage at right.***



EXPANDING CINCINNATI'S

THE present water demand in Cincinnati varies from 80 mgd to 120 mgd, averaging about 90 mgd. The population of the city proper is about 500,000; however, Cincinnati supplies water to adjacent areas in Hamilton County, serving in all about 650,000 people. Water service is complicated by the fact that the terrain is steep and hilly, with considerable variation in elevation. The water distribution system is divided into three principal areas —Eastern Hills, Central and Western Hills.

Improvements now under way, which were begun last year and will be substantially completed by the end of this year, are designed to meet the major needs for some forty years. The capacity will be increased to about 200 mgd. A large part of the funds for this new construction will be supplied by the Water Department, of which Carl A. Eberling is Superintendent. Black and Veatch of Kansas City, Missouri, are the Consulting Engineers. The costs of the improvements will aggregate upward of $12,000,000.

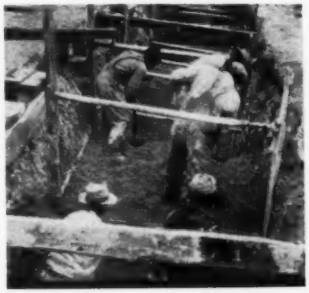
Water is obtained from the Ohio River through an intake crib located on the Kentucky side of the river, and is pumped to the filtration plant, which has been redesigned and enlarged. Treatment is by settling, coagulation, filtration and chlorination. The raw water is prechlorinated for algae and slime control; this procedure pays for itself many times over through virtual elimination of the necessity for regular cleaning of the raw water pipe lines.

Pumping Facilities

The high service pumping facilities are being expanded and revised. At present, water is delivered from the treatment plant through a tunnel to the main pumping station. From this station, the water is distributed to the various sections. One group of pumps consisting of four triple expansion engines and a turbine-driven centrifugal unit, with a total capacity of 78 mgd, delivers water to the Eastern Hills area. Another group of three 25-mgd triple expansion units delivers to the Central area. A booster station takes water from the Central area mains and pumps to the Western Hills, using one 10 mgd, two 7½ mgd and one 5 mgd motor driven pumps.

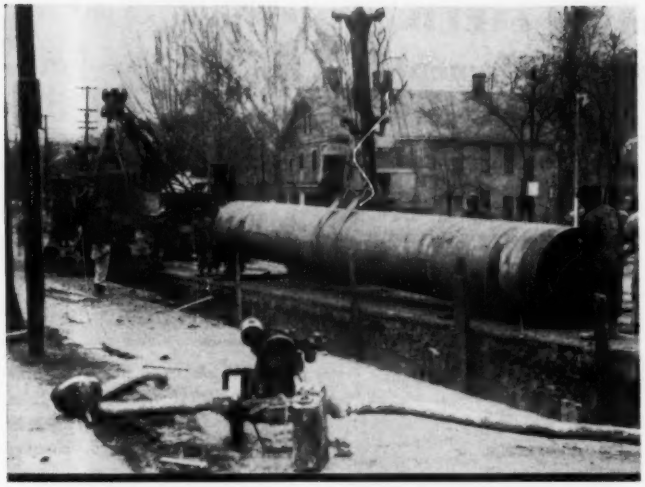
A new 96-in. tunnel, 2½ miles long, will connect the treatment plant with the new Tennyson Avenue pumping station. This plant will utilize electric power. There will be three 25-mgd pumps for the Eastern Hills area; and three for the Central area. This portion of the work is about completed; later the present steam pumping station will be electrified. A 48-inch line, 8,400 ft. long, will supplement present service in the Eastern Hills and another 48-inch line will augment the supply going to the Central area.

The Delta Avenue feeder, now completed, is an example of problems involved in laying pipe lines through city streets. The work of laying the feeder lines is extremely difficult because of the maze of other utility pipes and conduits in existence under the city streets, which for the most part can not be disturbed. The excavation work mostly involved hard digging through shale and clay though in some places the trench cut into old fills where seepage required constant pumping during construction. Pavement was broken 6 ft. wide, and air tools and hand load crane buckets were used for excavation which could not be re-



● ***PEA gravel was used for backfill to insure uniform support.***

● ***PLACING a Dresser joint.***



● ***SECTION** of steel pipe ready for lowering into trench.*

WATER SYSTEM

moved with a back-hoe. Trench jacks were used to prevent cave-ins. The trench was from 7 to 12 feet deep and the excavated material was removed from the site. Steel pipe, in 40-ft. lengths, manufactured and installed in accordance with American Water Works Association specifications was used. The length of open trench was limited to 50 to 100 feet. One to one and a half hours were required to lay each section of pipe depending upon the conditions of the trench, and the complexity of underground piping through which new pipe had to be threaded.

The steel pipe lengths were joined by controlled-compression couplings, a specialty of the Dresser Manufacturing Division. These couplings permit yielding and flexing of the pipe line with ground movements and unequal pressures caused by city traffic. This kind of coupling is particularly adaptable for city type of construction where it is impractical to close the street to traffic and only a short length of trench may be opened at any one time.

The exterior of the pipe line is coated with coal tar enamel and wrapped with asbestos felt to protect it from corrosion. The interior of the pipe will be lined with a mortar coating ¼ in. thick. To provide a complete back fill that would properly support the sections of steel pipe and fill all crevices, pea gravel was used nearly up to the pavement level.

In the Cincinnati system are 3½ mg of storage in elevated tanks; 18 mg in standpipes; and 136 mg in ground level storage. Approximately one-third of the standpipe and ground level storage can be utilized in equalizing peak demands. In the Western Hills area, which is most remote from the source of supply, consumption is only about 7% of the total water use. This is a residential area, but peak demands are exceptionally high, in some cases reaching 450% of the average; normally these peak demands are of short duration.

In order to provide the largest amount of elevated storage practical in the Western Hills area, a 2½ mg oblate spheroid tank was constructed. It is estimated this tank will contribute water to the system at the rate of at least 5 mgd; and this contribution would probably be doubled in case of extreme peak loads or short pumping station shut downs. This tank was designed and erected by Chicago Bridge & Iron Company. The design was selected because it was considered so pleasing as to be entirely unobjectionable in the residential neighborhood in which it is located.

The tank is 117 ft. in diameter, and 118 ft. high. The range in head between upper and lower water levels is 35 ft. The tank is supported on 16 cylindrical columns, arranged in a circle. The center column is fluted and 40 ft. in diameter. A special procedure was used in erection. Large assemblies were made on the ground and these were hoisted into position with a guyless derrick which used the riser and an access tube as its mast. This method saved scaffolding and reduced the amount of high-in-the-air hazardous work. The steel used in this tank was treated by the phoscote process.

● ***THE 2.5 MG oblate spheroid tank in the Western Hills area.***

REPORTS from the FIELD
Better Methods and Equipment

WE RENTED a shovel and backhoe and used it to dig sewer trenches and also to pick up old curb sections and load them on a truck. Another of our jobs was snow removal and we found the Nelson snow loader most effective for picking up snow and loading it on trucks.—Charles A. Ward, Superintendent of Public Works, Carthage, N. Y.

ting edge of a Hough loader to screed asphaltic concrete mix to the proper thickness above adjacent pavement areas so that the roller will compress the surface to the proper thickness. This device has saved many hours of hand labor by workers on trench resurfacing.—Omer H. Brodie, Street Superintendent,, Santa Monica, Calif.

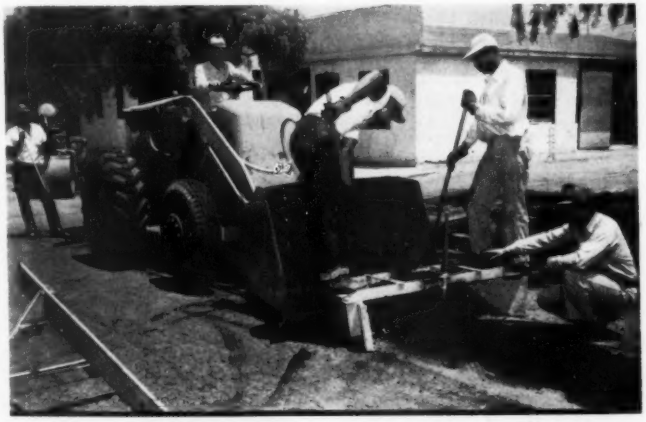
● ***HIGH platform helps in maintaining street lights and trimming trees. J. H. Wigglesworth, City Manager, Russell, Kansas.***

● ***Front-end blade for motor grader is used on garbage dump and for backfilling. Disc on end of regular blade trims back side of curb and slopes banks. L. C. Hulsey, City Sup't. and Engr., Rockmart, Ga.***

FOR DITCHING work, the city of Superior purchased a new Gradall excavator last year. This machine we found to be very adaptable to all kinds of street ditching. It is the only machine that we know of that can work around hydrants, trees, power poles and the many other obstructions to be found in ditching city streets.—Thomas M. Basterash, Director of Public Works, Superior, Wisc.

IN EXTENDING our water and sewer lines, we found a Longhorn ditcher and a Greenlee hydraulic pipe pusher to be about our most effective and economical equipment. —James L. Mattox, Manager, Light & Water Department, Columbus, Miss.

A 6-INCH CONCRETE pavement was constructed many years ago on a consolidated sand subgrade on a street having a slope of about 17%. As the pavement contracted, cracks developed, permitting surface water to filter into the sand subgrade. Apparently uneven subsidence of the subgrade resulted in cavities forming beneath the pavement, permitting surface water to erode portions of the subgrade down the hill and deposit the material on the level portion of the street below. To correct this situation and to stabilize the subgrade, a Koehring Model 10 Mud Jack was used. Cavities were filled and the slabs were brought to a uniform level along three blocks of the street. An attachment has been devised by Leslie Moore, our street foreman, which is mounted on the cut-



● ***SCREED, designed by Les Moore of Santa Monica, Calif., insures proper pavement cover for trench and other cuts.***

CHEMICAL TREATMENT of SLUDGE for SMALL COMMUNITIES

HUGH C. LEIBEE AND

RANDOLPH L. SMITH

Sanitary Engineers

CHEMICAL treatment of sewage solids has been practiced rather extensively for the past fifteen years in Minnesota and upper Wisconsin. Chemical treatment, of the type herein discussed, is normally suitable only for communities of less than 5000 population because of the sludge handling problem.

The chemical method is a simple, low cost, positive form of treatment that has certain advantages and disadvantages in comparison with the more standard method of treatment by digestion. The mechanics of the chemical method are as follows: The sewage solids are pumped to a 500-gallon concrete tank where anhydrous ferric chloride is added; the mixture is stirred for twenty seconds and then passed to small sand beds where it dewaters in about six hours. It is then removed and disposed of as indicated later in this article.

Digestion functions on the basis of holding the sewage solids for a period of thirty to forty days during which time gas can be produced and a varying amount of dissolved or suspended material can leave the digester with the supernatant liquor. Some biologists believe that digesters should not be used because during digestion the nitrogen that is contained in the organic matter is released as ammonia. This dissolves in the liquid and is carried back to the raw sewage through the supernatant. The nitrogen will eventually find its way into the effluent of the plant, either in the form of ammonia, or in the form of nitrate. In either case this nitrogen serves as a fertilizer for plant and algae growth in the stream or lake. As these plants grow in the presence of sunlight, they will assimilate carbon dioxide from the atmosphere and may thus rebuild as much organic material as was taken out in the sewage treatment plant. It is for this reason that some biologists claim that where a digester is used, the benefits of sewage treatment will not be fully realized.

The chemical method of treating sludge produces a condition wherein the solids are removed from the treatment process and, with the exception of the liquid returned during the dewatering process, are kept independent of the treatment process.

Public Health Considerations

Tests, showing total bacterial counts and coliform counts, both on the basis of grams of dry weight of sludge, have been made at a number of places. Table 1 shows such counts for raw and air-dried digested sludge, digester effluent

TABLE 1.—Total Counts/Gram Dry Weight ($\times 10^5$) and Coliform Counts/Gram Dry Weight (10^5) Lactose Broth Method For Raw and Treated Sludges in some Minnesota and Wisconsin plants.

Place	Raw Sewage		Air-Dried Sludge		Digester Effluent		$FeCl_3$ Treated		$FeCl_3$ & $CuSO_4$		%$CuSO_4$
	Total	Coliform	Total	Coliform	Total	Coliform	Total	Coliform	Total	Coliform	
Wayzata	53,144	3.94	20,190	3.35	...	...	...	...	...	...	...
	...	...	56,540	22.4	...	...	...	...	...	...	...
Excelsior	22,859	4.55	15,115	3.35	13,146	1,791	...	...	...	...	..
Waconia	...	...	5,644	4.56	...	...	...	...	...	...	...
River Falls	124,870	338.	...	...	...	...	11,640	57.9	3,619	3.67	10%
	...	...	...	...	...	...	...	...	1,370	0.97	20%
New Ulm	...	...	36,120	2.69	...	...	...	...	...	...	...
Owatonna	..	...	...	...	1,063	20.4	...	...	...	...	...
	...	...	...	...	3,981	18.3	...	...	...	...	...
Lakefield	...	...	...	...	...	...	9,452	51.6	19.2	0.38	20%
	...	...	...	...	...	...	...	101.8	...	2.8	20%
White Bear Lake	...	...	8,204	3.1	...	...	...	..	...	...	...

and chemically treated sludge at several plants.

Other laboratory tests have shown that: ferric chloride on broth culture of E.coli will produce sterile conditions when in excess of amounts of 2000 ppm; ferric chloride on broth culture of E.typhi will produce sterile conditions when in excess of 2000 ppm; ferric chloride, plus 10% copper sulphate on broth cultures of E. coli and E. typhi will produce sterile conditions when in amounts of 1600 ppm; ferric chloride plus 10% copper sulphate on sterilized sludge cultures of E.coli and E.typhi will produce sterile conditions when in excess of 1600 ppm; under plant operating conditions, ferric chloride plus 10% copper sulphate will kill 99% of all micro-organisms present in the sewage sludge; when sludge has been sterilized and then inoculated with E.typhi, the E.typhi will grow as well on the sterilized sludge as it would on broth.

It will be noted that the usage of ferric chloride in the ten plants in table herewith averaged more than 2500 ppm. No copper sulphate was being used at any plant. Copper sulphate can be used at a saving as a substitute for ferric chloride but is not as easy to handle as ferric chloride, not being available at this time in the anhydrous form.

The physical effect of the chemical treatment of sludge is to reduce the pH to between 3.0 and 3.5 and maintain this condition for a period of hours.

The conclusion can be offered that chemical treatment of sludge offers protection to the public health at least equal to that offered by the digestion method; and, with the addition of large amounts of copper sulphate or similar germicide could offer better protection.

Operational Conditions

In the majority of plants first going into operation, the operator, for the period of the first week or so, has had difficulty in producing successful dewatering with chemicals. After this period, the operators have been all very successful in processing sludge; the average number of batches missed is about one in 800. The effect of a missed batch is to have the batch fail to dewater and require that the operator clean the bed with a pail. The psychological effect of a potential failure is to maintain a slightly higher use of chemical than would otherwise be used.

The period of time required for dewatering varies from a few hours up to twenty-four hours, or longer, depending on various factors. Many operators use the same bed day after day. The sludge, when removed from the bed, is almost completely odorless. The sand on the sand beds is normally a clean, coarse material and requires replacement about every four months.

The dewatered sludge is usually hauled by the Village truck to farm land for disposition as a thin layer on plowed land or land in fallow. It should not be used as fertilizer on residential lawns because of the potential mouth contact of small children. It should not be piled outside where it can become reinoculated and extremely objectionable.

The chore of haulage can become systematized because of its regularity and should provide at least equal protection to the public health as is provided in the disposition of digested sludge.

Comparison of Costs

Recently a comparison cost study was prepared by a Minnesota consulting engineer for the Village of Cameron, Wisconsin. This village has an actual population of about 800 and a design equivalent population of 3200 because of the presence of a large milk processing plant. The cost of the digester and sand bed units was estimated as $30,900; the cost of the chemical sludge treatment construction as $11,000. The summation comparison of both plants on a yearly basis is shown in Table 3.

It is to be noted that the digester does not include gas collection and burning equipment and is not mechanized; that the sand bed construction could be made of much lower cost material than estimated but that the digester construction is minimum cost construction. Depreciation represents normal wear and tear; obsolescence represents loss caused by failure to anticipate true conditions for the period of the bond issue; a waste treatment plant because it handles the end product of a community has a very high obsolescence factor. For instance, a new large waste producing industry in the community can cause heavy expense for remodeling the sewage treatment plant.

There has been a change from the point of view of high initial costs and low up-keep costs to low initial costs and high upkeep costs because of the change in economic conditions. A recent cost analysis of the solids handling methods for Chisholm, Minn., a community of

(*Continued on page* 60)

Table 2. Operation Records of Sewage Treatment Plants Using Chemical Sludge Treatment

	Present Pop.	Design Equiv. Pop.	Loading % Capacity	Area of Sand Beds	Gallons Sludge/ Day	Lbs. $FeCl_3$ 100 gals. Sludge
Chatfield	1,602	2,088	80%	189 sf.	900	0.78
Cokato	1,393	1,398	150	210	600	1.67
Foley	1,093	4,560	100	600	1,066	7.3
Howard Lake	982	4,536	30	768	700	2.3
Kenyon	1,646	5,800	80	1,140	1,500	2.2
Lakefield	1,649	2,200	90	320	900	3.05
Lindstrom-Chisago City	1,416	3,060	70	480	500	2.6
River Falls	3,455	4,000	300	500	2,250	1.22
Rothsay	525	1,362	80	250	300	2.67
Ulen	562	1,200	50	250	150	2.0

The average ferric chloride dosage per 100 gals. of sludge at all plants is 2.58 pounds. The filtrate from the sand beds at Foley included 50% of the iron added to the sludge.

The average design size of sand bed area is 0.2 sq. ft. per capita; the actual daily use approximates 0.05 sq. ft. per capita. The sludge volume approximates seven thousand gallons per million gallons of sewage. In the case of two-stage treatment plants using chemical treatment of sludge and including tile media in the first stage and rock media in the second stage, difficulty has been obtained in the dewatering of the sludge from the rock media stage. This is explainable by the fact that anaerobic pockets of sludge are present in the rock media and difficulty can normally be expected from such sludge, whether processed on a vacuum filter or by direct chemical treatment.

● ***SUBSEALING pavements with hot bitumen to prevent pumping of pavement slabs.***

PLAN NOW FOR SPRING Maintenance

B. W. DAVIS,

Chief Equipment Engineer,

N. C. State Highway & Public Works Commission

AFTER a *normal* winter there is little "special" preparation necessary to get North Carolina roads ready for spring and summer traffic. Weather conditions make it practical to repair pavement breaks during at least a part of each month of the year. It is the policy of the North Carolina Highway Dept. to make permanent repairs of pavement breaks as soon as practical after breaks occur. An extremely wet and cold season will materially increase pavement failures and a long wet season, (summer or winter) increases the number and intensity of pumping slabs. Proper shoulder maintenance, sub-drains through the shoulders and a bituminous subseal with M-18-42 Grade B asphalt is, in our opinion, the most effective treatment for pumping slabs.

While maintenance forces always inspect and seal pavement cracks and joints in the spring (and in the fall), again it is standard policy to seal and reseal cracks and joints whenever they are open; or, in other words, keep cracks and joints sealed. North Carolina standards for "Crack and Joint Maintenance" give the field engineer the option of sealing with RC-2 heated to 120° and covered with dry sand or with AP-5 (at 275° to 325° F.) or RT-9 (at 150° to 225° F.) and covered with dry sand.

Early Spring Work

As early in the spring "as weather conditions permit, preferably before April 1 and in no case later than May 1", maintenance forces rework or cut down grass covered shoulders that have become built-up to the point where they interfere with proper drainage. In reworking shoulders, we attempt to preserve, respread, and rebond the sod, topsoil, roots and humus after the removal of the surplus material has been completed. We also attempt to leave the shoulders with a slope of ½ inch to ¾ inch per foot.

We strive to keep the elevation of the pavement side of the shoulder flush with the pavement but find this objective practically impossible when the pavement is 18 ft. or even 20 ft. wide.

Removing the excess shoulder material is a job that has been made less expensive by the use of 4 types of loaders: (1) The self-propelled and self-fed belt type loader (Adams Travel-loader, Athey Force Feed, or PettiboneMulliken Model 52); (2) The wheel tractor loader with front end shovel type attachment; (3) The crawler tractor loader with front end attachment; or (4) The self-fed bucket elevator type loader.

For this job of windrow loading, our preference for the four types of loaders referred to is in the order named.

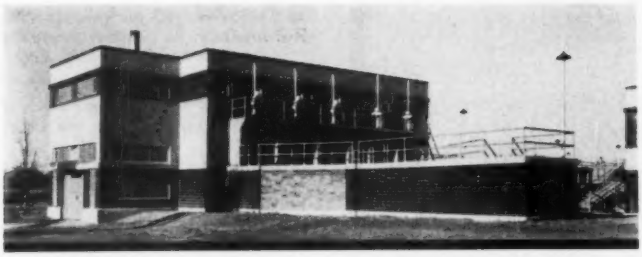
Side ditch cleaning either precedes the shoulder reworking or is done at the same time. Maintenance Engineers have for a long time looked for a unit that would open the side ditch or cut the high shoulder and load the excess material into a truck in one continuous operation. Such a unit has not to my knowledge made its appearance. If this combination machine should become available it would probably cost $20,000 or more; it would be a one-purpose unit that would be in demand for only a fraction of the year; and, hence, it would be impractical because of the cost. The use of a heavy duty tandem drive motor grader (or in exceptionally flat and wet areas a tractor-drawn grader) to windrow the surplus ditch and shoulder material, followed by a loader, appears to be the most practical means of handling this job. The use of such modern equipment has materially reduced the cost of this operation.

Sign maintenance can be and is carried on during the winter months. However, a general inspection and "clean-up" of signs is ordered in early spring. The pavement marking cannot be started until late spring when the pavement is dry and the weather not extremely cold.

Culverts and bridges, including their inlets and outlets, are inspected and cleaned in the early spring.

Vegetation on shoulders, slopes, and roadside areas is reworked, reseeded and refertilized each spring as conditions require.

● ***FRONT-end loader handles excess material into truck.***



● *SCREEN house at Denver's new plant was doubled in size.*

● *C. E. Harness, sanitary engineer.*

DENVER EXPANDS its

Guy Browning Arthur

THE additions to its sewage treating plant which Denver has recently constructed, merge intimately into the old plant. Several new developments will attract the interest of sanitary engineers. Smoother operation is developing naturally with more capacity for handling the sewage load.

In 1937 the city-county voted a bond issue of $4,885,000, with which the original plant was built. The additions now nearing completion have used all but a small fraction of $1,750,000 voted in another bond issue in 1948.

The plant now serves a population of 420,000 in Denver and adjoining areas. Industrial waste is 15% of the liquid volume, and 23% of the organic total. The packing plants pass their sewage over ⅛-inch screens before feeding it into the sewers leading to the sewage plant. All of the load flows to the plant by gravity except 1.5 mgd which is raised 20 feet by pumps.

Design Details

Originally the plant was designed to handle 55 mgd, with a maximum of 75 million. The present additions raise the normal capacity to 84 mgd, with a maximum of 114 million. The sewage flow varies from 40 to 85 mgd, with an average over recent months of 61.

The original design provided primary treatment with chemical precipitation, using ferrous chloride, followed by effluent filters. The special filters did not meet local needs, and after a few years were taken out. The basins in which they had been installed are now used for chlorine detention. Other features were separate sludge digestion, and open-air drying beds. Four Dorr clarifiers, 140 ft. in diameter, were installed.

New equipment consists of two coarse screens, a fine screen, a grit chamber, an aerator, two settling tanks, two digesters, and Venturi meters. New construction doubled the size of the laboratory and the screen house, and added a new digester building.

The suppliers were: Builders-Providence for the Venturi meters; Link-Belt for settling tanks, screens, and grit chamber; and Pacific Flush Tank Company for the covers for the new digesters and the heat exchange units.

Black & Veatch, of Kansas City, were the designing engineers. The local sanitary engineer is C. E. Harness, and the City Engineer is Terry Owens. Thos. Bate & Sons, of Houton, Denver, and Dallas, is the contractor.

C. P. Gunson has been superintendent of the treatment plant ever since it was built. He has developed a number of new methods, some of which he has patented. One of them, his Gunson Steam Ejector, is manufactured and sold to treatment plants. Nearly one hundred experiments have been made under his direction to find better ways of handling sewage, including trials with electricity and sound waves to aid in sedimentation of the sewage. His influence is felt especially in his fresh and imaginative approach, and his hand is clearly seen in the design of the additions now being completed.

The cycle of treatment in the new plant can be traced easily. Incoming sewage is measured through the Venturi meters at the head of the plant, and then flows over screens with bars spaced ¾ ins. apart. The material left on the screens is incinerated. The screened sewage continues through the grit chambers.

In the old procedure the sewage was aerated 15 minutes and flocculated 15 minutes. In the new flowplan the flocculation is omitted, and the aeration is continued to 30 minutes, for a flow of 84 mgd. Now there are 6 settling tanks: the four Dorr clarifiers originally installed, plus the two new Link-Belt Circuline tanks. From these settling tanks the effluent returns through a common flume, passing through a ¼-in. screen, to the chlorine detention tanks, and thence to the South Platte River.

Four digesters 85 ft. in diameter and 30 ft. high were installed in the old plant. They were heated by internal hot water coils. Two new ones of the same size have now been added. All of the six are heated with three 1,000,000 BTU per hour Pacific Flush Tank external heat exchange units. The central heating tank is 23 ft. in diameter and 28 ft. high.

By circulating the sewage through the battery of heating units and the central heating tank its temperature is raised to 90 degrees F. The increment for each of the six circuits is about 5 degrees, though it is less in the first one and much higher, nearly 10 degrees, in the last.

For digestion the sludge is car-

● ***DENVER'S sewage treatment plant, with the South Platte River in the foreground.***

Sewage Treatment Plant

ried into four digesters for primary action, and then into the two secondary tanks for secondary action.

Sludge and Supernatant

Two of Mr. Gunson's innovations are introduced here. The first is for sludge treatment. In many systems cold, raw, sludge is introduced into warm digesters. This chills—changes the environment—of the bacteria already acting in favorable environment in the digesters. In the new plant, this is avoided by pre-heating the raw sludge to the same temperature as that in the digesters. In addition, the sludge is inoculated or seeded with pre-digested sludge from the supernatant liquor tank.

A second improvement is in the handling of the supernatant liquor. When this liquor, deficient in oxygen, goes into the plant stream, it robs oxygen from the fresh sewage, and lowers plant efficiency. In the new plant the supernatant liquor is drawn from the secondary digesters into a holding tank. It is here aerated for 5 minutes; it is then allowed to settle for 30 minutes. The precipitated solids are then pumped to the central heating tank as seeding material for the incoming raw sludge which is being heated.

After the solids are removed, the liquor is aerated for two hours to satisfy its immediate oxygen demand. It is returned after this aeration to the head of the plant.

About 546,000 cu. ft. of gas are produced daily in the digesters, and is recovered for use as fuel. Its composition has a fuel value of 700 BTU per cu. ft. The plant sells 300,000 cu. ft. to the public utility, which is piped to the American Smelting and Refining Company. The treatment plant uses 150,000 cu. ft. of the gas for process heating, and wastes the remainder.

● ***INTERIOR view of laboratory showing the facilities provided.***

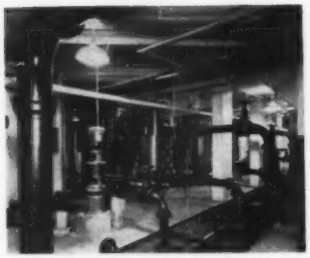
The East Side Plant

The city-county has a small treatment plant on the East Side, where another of Mr. Gunson's inventions is installed. Instead of trickling filters, he used a drum-frame mounted on a shaft which turns slowly. Brushes with coarse straw bristles are mounted on the outer ribs of the frame, and pick up solid particles from the sewage stream. In their revolution they expose these solids to the air long enough to accomplish considerable aeration. The solids build up on the bristles for some time, and then slough off. The removal of BOD is about 95%.

Grease is another by-product marketed from the plant. It is collected by a special rendering and settling tank worked out here in the plant. In normal operation one carload of grease is shipped each month, going to such special purposes as the making of soap and chemical products.

An unusually small working force is employed at the plant, considering the volume of sewage processed. Normally there are 42 persons on the payroll: The superintendent and assistant in the office, one chemist and an assistant, one bacteriologist, three mechanics, 24 operators, and the necessary unskilled labor.

Because Denver is in an irrigated area, the water in the South Platte River is one of the most im-



● ***SLUDGE heat exchange units.***

portant local resources. The level of the river is drawn down to practically nothing in mid-summer. At such times the effluent from the sewage plant is almost the main supply to the impounding irrigation reservoirs south of the city. No matter how inocuous this effluent is made at the treatment plant, it is still not desirable as a main supply behind the dams. Denver has found it expensive to overcome this condition, but it has worked out a satisfactory solution.

About 40 miles west of the city, just across the Continental Divide, it has built diversion dams on four branches of Williams Fork River. Water is drawn from these branches, behind the diversion dams, through steel pipe to a tunnel which bores through the Divide and empties into Clear Creek. The tunnel is 3000 feet long, with a 7-ft. horseshoe cross-section.

Originally this flow was to be carried through a canal from near the mouth of Clear Creek to the treatment plant. The canal proved to be porous and the loss of water was excessive. Now it empties into the river, near enough to the discharge from the plant to dilute the effluent.

● ● ●

Water Usage by Manufacturing Industries

A survey of water usage per unit of production was recently conducted by the National Association of Manufacturers and reported in a bulletin of the National Council for Stream Improvement. The survey showed the following: Viscose rayon, 180,000 to 200,000 gals. per ton of production; rayon yarns, 250,000 to 404,000 per ton; woolens and worsteds, 140,000 gallons per ton; whiskey, 80,000 gals. of water per 1,000 gallons of whiskey; rolled steel, 110,000 gals. per ton; synthetic gasoline 15,800,000 gals. per 1,000 bbls.; and aviation gasoline, 1,050,000 gals. per 1,000 bbls.

Sludge Treatment

(*Continued from page 56*)

8000 people, with industrial wastes, gives a comparison cost for all yearly charges, including principal and interest, of $15,046 for digestion, $15,287 for vacuum filtration and $9,225 for chemical treatment on sand beds.

The chemical method of sludge treatment has one major disadvantage—the requirement that sludge be hauled and disposed of on farm land at intervals not exceeding ten days, winter and summer. The haulage problem in the ten plants studied in this report have not been critical and have been successfully handled in all communities, winter and summer in a northern climate, without material objections.

The chemical method has certain advantages: first, the process is relatively odorless; second, it is simple and positive; third, it is a low cost method; fourth, it is extremely flexible and will take a heavy overload; and fifth, it eliminates practically all explosion hazard.

TABLE 3—Construction Cost Data

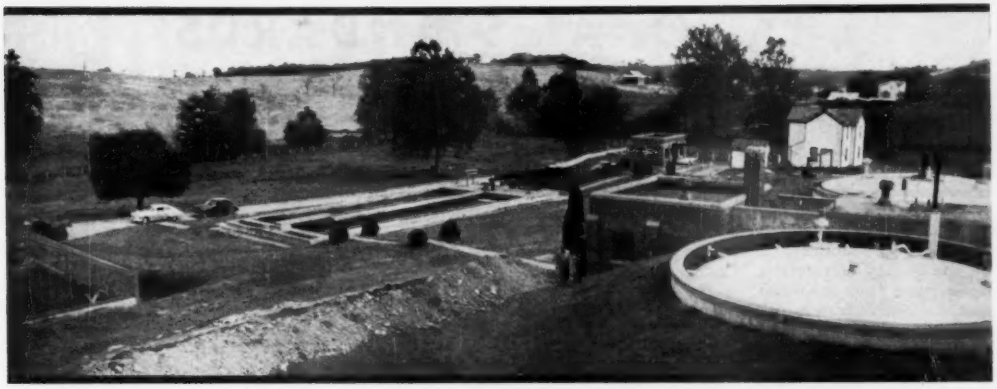
DIGESTION PLANT (No Gas Collection or Gas Heating)

Principal at 20 years	$1,545.00
Average interest at 4%	618.00
Labor (sludge drying, same as chem. beds)	
Sludge hauling (two times a year)	100.00
Power (same as chem. beds)	
Digester heat	200.00
Explosion risk insurance	75.00
Maintenance & repairs	150.00
Depreciation	
Concrete—2% per year	193.00
Metal & machinery—10% per year	170.00
Heating coils—20% per year	82.00
Obsolescence	
Loss of concrete constr. 8% per yr.	771.00
Metal—included in depreciation	
Total Yearly Cost of Digestion Process	$3,904.00

CHEMICAL SLUDGE TREATMENT PLANT (All Concrete Construction)

Principal at 20 years	$ 550.00
Average interest at 4%	220.00
Labor (sludge drying, same as digestion)	
Sludge hauling (two times per week)	450.00
Power (same as digestion)	
Heat (sand bed area)	150.00
Chemicals	610.00
Depreciation	
Concrete—2% per year	125.00
Metal & Machinery—10% per yr.	80.00
Obsolescence	50.00
Total Yearly Cost of Chemical Sludge Treatment	$2,235.00

● ***INDOOR beds used for chemically treated sludge dewatering.***



Experience with • CLOROBEN • in Sludge Digestion

O. R. HOLTZ
Sup't. of Sanitation, Staunton, Va.

THE sewage disposal system at Staunton, Virginia, consists of a hand cleaned bar screen, Parshall flume, two primary sedimentation tanks, digesters and post chlorination. Digestion is two-stage and heated, utilizing the gas which is produced. Sludge is dried in glass enclosed de-watering beds. Sewage flow is about 3.5 mgd. Quarters are furnished the plant operator and his family at the plant site. Digester gas is piped to his house for cooking purposes and electricity is also furnished by the city.

The writer cannot give an accurate first hand account of the conditions in existence at the plant prior to the addition of Cloroben to the digesters. However, it is known that the plant was experiencing an aggravated scum mat in the primary digester with poor digestion, resulting in a poor quality of supernatant, which was black in color, with a pronounced hydrogen sulphide odor. Difficulty was experienced with de-watering of the sludge, and numerous complaints were received concerning the odors from the sludge drying beds.

Gas pressure was approximately 5 lbs. and the gas flames burned yellow. During the winter months it was difficult to maintain the heat in the digester and to supply sufficient gas for cooking purposes at the living quarters.

There had been considerable corrosion at the gas burners and stacks. The moisture traps in the gas lines collected so much water that they had to be drained daily. This indicated that the gas produced by digestion was of poor quality and contained excessive hydrogen sulphide and moisture. In order to maintain digester temperature, all ten gas burners in the boiler were constantly in use. Naturally, it was assumed that the poor quality of the digester gas was evidence of poor digestion.

Cloroben treatment to the digesters was instituted for the purpose of reducing the existing scum mat and improving the digestion, gas and sludge de-watering characteristics. The initial quantity of Cloroben applied was calculated to establish 100 ppm concentration in the contents of the digester. This was applied in one dose, mixed well with water for proper dispersion, and pumped to the digester. Daily, thereafter, additions of 100 ppm to the volume of the sludge pumped to the primary digester were made. Cloroben was introduced at the sludge sump at the head of the primary sedimentation tanks. About 3 pints of Cloroben were added daily.

After a short time the gas pressure rose to 7 lbs. and the gas appeared to burn hotter. Digester temperature was maintained by seven burners where formerly ten had been used. The gas burned with a bluer flame and the moisture traps in the gas lines were found to be dry.

There was no recurrence of gas pressure drop during the winter months and corrosion has been greatly reduced. The supernatant from the secondary slowly changed from black to a yellow straw color and at present there is no hydrogen sulphide odor. Stratification is well defined. The sludge at the drying beds is of excellent quality, de-watering so well that it may be removed from the beds after ten days. The sludge is drawn to a depth of 18 inches. There is no objectionable odor. The sludge sump is free of grease, and odorless.

In order to determine just what was happening, the Cloroben application was suspended for a period of 15 days. The water in the traps immediately returned, and after Cloroben was re-applied, disappeared again. Digester temperature is being maintained at 90 degrees. The remaining scum in the sample well of the primary digester is soft.

It is unfortunate that actual measurements of the scum reduction cannot easily be made due to the fact that the primary digester is sealed, and if opened gas pressure would be lost. It is hoped that in the near future conditions will allow the opening of the primary digester for inspection.

The writer feels that Cloroben has materially aided sludge digestion and de-watering, and therefore the City of Staunton has incorporated Cloroben as standard operating procedure in plant operation and maintenance.

RATIONAL STANDARDS for POLLUTIONAL DISCHARGES

F. E. DANIELS
Consulting Chief Chemist, Penna. Dep't. of Health

AS a result of studies of the effects of pollutional discharges on the quality of receiving waters, there have been proposed, in the past, various factors as guides for mitigating the objectionable conditions resulting from such discharges. These requirements have ranged from dilution to specific organic composition. A review of the developing history of these guides or standards is interesting and instructive but will not be given here.

Our latest standards have led to the classification of streams in accordance with certain types of use, and the loadings imposed on each class of streams are based upon the broad usages and values to the community of these streams. The stream grouping in Pennsylvania, for instance, is threefold—A, B and C. Streams of the A category are of high quality, near their original state of purity, and it is desired to preserve them in this condition. The C streams are in bad condition and cannot, at present, be utilized for much more than waste disposal, though future improvements are possible. The large group of B streams cover all those in a wide range of intermediate states, and are the ones which give the greatest concern in respect to the discharge of sewage and industrial waste.

Strictly speaking, it is not correct to refer to these streams as "classes", since definite and complete criteria to fix the dividing lines between the categories have not been adopted. So many factors have to be considered that it is a problem to decide what will be necessary to insure desirable stream conditions, while, at the same time unnecessary requirements will not be demanded from the waste producers.

Standard Requirements

Of late, in order to have at hand for ready use a simple designation for the necessary requirements for waste treatment, the expression "per cent reduction" or "per cent removal" of certain characteristics

has been used. This may be applicable to domestic or municipal sewage since the characteristics and strengths of such sewages are well known. But on industrial wastes it means nothing until by laborious and costly investigation the qualities and strengths of each particular raw waste have been determined.

There is, however, a very useful place for "per cent removal." It is a convenient indicator or measure of the efficiency of any unit of a treatment works or of a process. Here the input is readily sampled and analyzed, as well as the output. A comparison of the analytical figures in each case will show at once the efficiency in per cent removal.

But the standard set for the final effluent to be discharged into a stream should never be in terms of "per cent removal" of anything. Furthermore, a set "per cent reduction" applied to all wastes in a locality may produce under-treatment of some and over-treatment of others. This will result in unfairness and bring deserved criticism.

If, however, we limit "per cent reduction" to sewage and insist that an equivalent treatment of an industrial waste is one which produces an effluent equal to that produced from the sewage, regardless of the strength of the raw waste, we have set a requirement which will be fair both to the stream and to the producers. And we are saved a long and costly investigation of each raw waste in order to designate what per cent must be removed. It is necessary only to check the effluent at the point of discharge.

Examples of Wastes

For comparative purposes, the organic content, which is subject to decomposition and will rapidly absorb oxygen, is usually important. Let us take, for example, a brewery waste having a very high BOD, perhaps 2000 ppm, and some other waste, with perhaps only 30 or 40 ppm BOD, in a locality where complete sewage treatment is demanded which gives 85% reduction of BOD.

If we say in each case there must be 85% reduction of BOD, then in the first case the pollution would still be so intolerable that it is doubtful that any marked improvement could be noticed. In the second case, it is not likely that the specified reduction could be economically accomplished because of the approach to what has been called the "irreducible minimum." This would severely penalize the weak effluent and fail to obtain the results desired from the strong.

Since an average domestic or municipal sewage carries a BOD of 200 ppm, then the requirement should be an effluent of not over 30 ppm BOD in each case. This will be fair to the weak waste and will demand that the stream be protected equally in each instance.

We have considered only average conditions. Certain types of secondary sewage treatment works may be expected to turn out effluents of 10 to 20 ppm BOD; and to find effluents that are perfectly stable or non-putrescible is not at all common.

There is no just reason, other things being equal, why any industry should be compelled to treat a waste which already meets the required standards simply because other industries have to do so. Nor is it fair to require that all plants of the same kind of industry must turn out the same grade of effluent regardless of the local conditions.

However, if an industry wishes to move from a C stream to a B stream, that industry will have to

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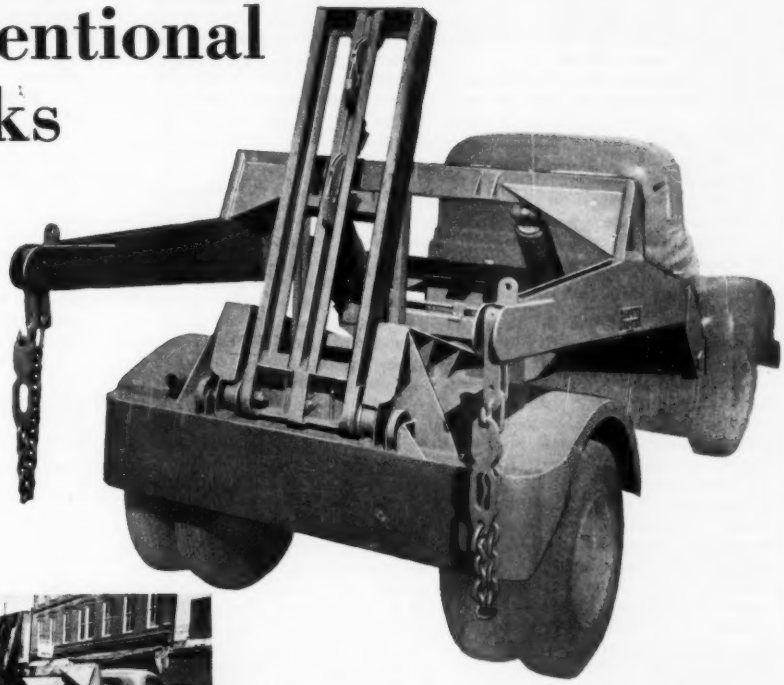
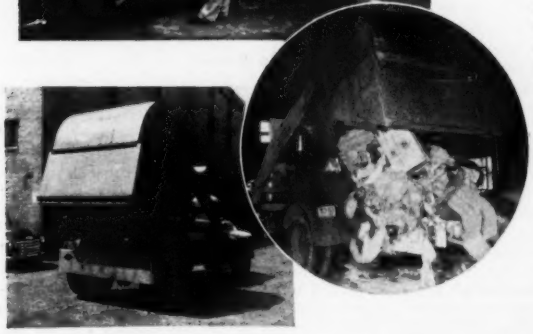
Eliminates 3 to 5 Conventional Trucks



THREE STAGES of quick pick-up, hauling and dumping are shown while Dempster-Dumpster is at work in Norfolk, Va.



One truck-mounted Dempster-Dumpster picks up, hauls and empties, one after another, a multiple number of detachable containers . . . eliminating 3 to 5 conventional trucks and crews. Containers are spotted at hospitals, schools, business establishments, etc. and loaded by the user. Container sizes range up to more than three times the capacity of the average dump truck body. For low cost, efficient and sanitary bulk rubbish collection, your city needs the Dempster-Dumpster System. Manufactured exclusively by Dempster Brothers, Inc.

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pay the price. This means that the stream will be the deciding factor instead of some general requirement for that particular type of industry.

It is believed that we already have sufficient data at hand to enable us to decide upon the degree of sewage treatment necessary or even desirable on any of our streams. It then becomes necessary only to formulate the limits of analytical figures to characterize an industrial waste effluent so as to make it such that the contemplated uses of the stream will not be impaired.

It is further recognized that public health has progressed beyond the mere stage of saving lives. We desire to live well; and we must keep our streams in proper condition not only for use but also to be agreeable to our senses.

Toxic and Polluting Matters

The foregoing discussion has had to do mainly with regard to the organic content of wastes.

Toxic, and other polluting matters of an inorganic or mineral nature, must be considered one by one and each eliminated to such an extent as will be tolerated legally or otherwise.

Since many "toxic and other polluting matters" do not normally occur in domestic or municipal sewage, the effluent content of such would be zero. Therefore, since it may be unnecessary or even impossible to reduce the content in an industrial waste to an absolute zero, the reason for the reduction to a point of tolerance is evident. Furthermore, many substances which are toxic in concentrated amounts become non-toxic in small quantities.

Already a precedent has been established by law in connection with the Delaware River (INCODEL)) in that definite figures have been adopted for each zone of the river and tidal estuary.

In order that reasonable consideration be given to every waste producing industrial plant, it is understood that the foregoing discussion is from the standpoint of the actual stream requirement. This is the goal set for the desired conditions to be obtained in the stream.

Should it happen that, after honest effort of the responsible owners and their retained experts, a plant should fail to meet the conditions set forth in the orders, then the particular case should be thoroughly reviewed and such modification agreed upon which will, for the time being, at least, accomplish reasonable improvement without causing serious harm to anyone.

Also, in such cases, it is to be understood that whenever local conditions or improved methods will warrant a change for the better, such changes will be adopted. Any action taken by governing bodies is reviewable by the courts; therefore, it is imperative that any orders shall be justified. To this end, and to avoid misunderstanding and argument, expressions used to describe the various phases of the foregoing should be unmistakably defined.

What Should Be Required

Having endeavored to develop a discussion of stream pollution by sewage and industrial waste effluents from several points of view, it is desirable to show what is to be required of effluents to be allowed to enter streams of various types and qualities.

If we use the effluents from the several methods of sewage treatment as bases for comparison, then the problem as to organic content becomes less complicated. But to formulate a series of tables to fit all possible requirements would entail an unwarranted effort. Each particular case should be considered by itself so that the conditions to be fulfilled may then be set forth.

As noted previously, the type of sewage treatment is easily selected to fit the local conditions. The requirements for the industrial waste effluent should then be as follows:

1. The turbidity should be at least as low as that of the sewage effluent.

2. The BOD should be at least as low as that of the sewage effluent.

3. The character of the industrial waste effluent will have to be carefully considered, both as to composition and effects. Each component must be properly evaluated. Toxic, or otherwise objectionable constituents, will have to be reduced to a point of tolerance, depending upon either the substance itself or the uses of the stream. No general rule can be set forth.

4. When this has been accomplished, a table of requirements can then be made to fit the case and included in the permit for the treatment works.

Corpus Christi Cleanup Campaign

In a recent issue of the Texas Health Bulletin, E. C. Nelson describes a July and August cleanup of Corpus Christi which was initiated following the onset of many cases of infant diarrhea and polio. In this city, the housing situation, as found by the investigators was bad. "There were about 10,000 substandard housing units. That means approximately 40,000 people were affected out of a population of 113,000. Incidentally the term 'substandard' is a kind word to use, for most of these units are flimsy, deteriorated cracker-box affairs, totally unfit for human habitation. Inside plumbing was unheard of. . ." Fantastic accumulations of trash were found in these substandard areas.

"A very high fly density was found by using the Scudder Grill as a measuring device. In some areas, counts reached 200 on a single attractant. A relatively sanitary neighborhood might turn up 2 flies per attractant, but the low counts in . . . substandard areas ranged from 50 to 60.

By the beginning of August, public health teams had sprayed 16,000 homes with 3% chlordane in a kerosene base; 11,000 gallons of insecticides were used; and 9,000 pounds of insecticide powder were applied to pit toilets.

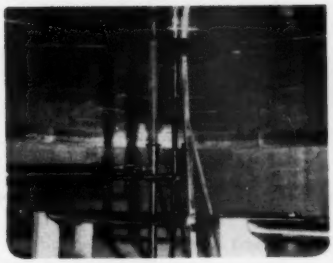
"It is difficult to draw any definite conclusions regarding the part played by the sanitation drive in reducing the high incidence of diarrheal complaints, but it is interesting to note that during the closing days of the drive, (weekly) cases dropped from a high of 190 to a low of 52. This was over an 11-week period. Polio dropped from a high of 12 to 14 daily to a low of 1 or 2 every three or four days."

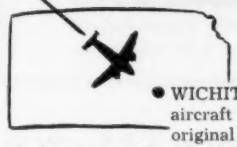
• • •

"Old Smoky" is Out of Business

For fifty years, "Old Smoky", a mountain of smoldering garbage, made the Lincoln, Ill., dump an eyesore that was equally trying on the nostrils. Adoption of the landfill method has put out the fire, eliminated rats and flies that used to call the dump their home, and permitted the disposal area to pass the sight and sniff tests. A larger disposal unit, an International TD-14A tractor with a 2-yd. Drott bull-clam, has been purchased to care for the increasing volume of refuse.

How Wichita Used P. F. T. Adaptability in Long Range Planning for Sewage Treatment Plant

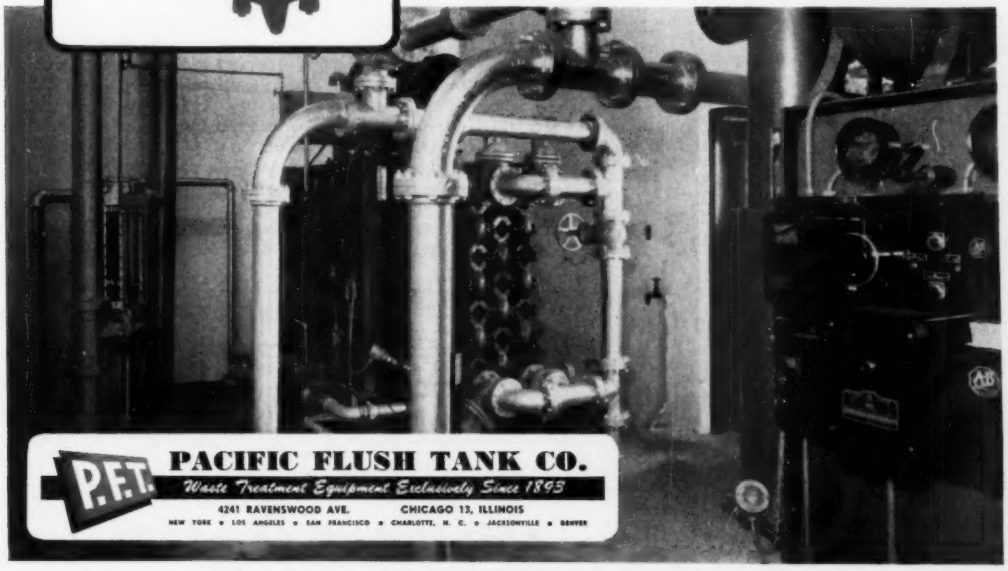




● WICHITA, KANSAS, with its expanding aircraft production, has far outgrown its original sewage treatment plant. As a part of a long-range plan, the three fixed cover digesters with a combined capacity of 374,640 cu. ft. were supplemented in 1943 by two 75-foot diameter open storage tanks. In 1948-49 P. F. T. Floating Covers were placed on these new digesters, and P. F. T. Digester Heaters were included to bring the total heated digestion capacity up to 624,400 cu. ft.

Lower photograph shows the two P. F. T. No. 750 Digester Heater and Heat Exchangers arranged for sludge gas firing and equipped with Type "B" controls to automatically maintain the sludge digesters at the optimum temperature for best digestion. The sludge tubes in each heat exchanger are arranged for circulation through two sections of the heater in parallel.

The "undercover" view at the top shows the smooth unobstructed floating cover under-surface and the piping within the digester, and the P. F. T. Supernatant Selector. P. F. T. Supernatant Gauges and Samplers and Gas Safety Equipment in the digester building were included in this controlled digestion system. This is another case where P. F. T. equipment readily dovetailed with existing plant structures and equipment to handle increased loadings. Black & Veatch, Kansas City, Missouri, were consulting engineers, actively assisted by E. F. Miltner, Plant Superintendent.



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PUBLIC WORKS DIGESTS

THIS section digests and briefs the important articles appearing in the periodicals that reached this office prior to the 15th of the previous month. Appended are Bibliographies of all principal articles in these publications.

WATER WORKS . . 66
HIGHWAYS AND AIRPORTS . . 76
SEWERAGE AND REFUSE . . 83

THE WATER WORKS DIGEST

U. S. P. H. S. On Fluoridation

Replying to questions addressed to him by the A.W.W.A. H. Trendly Dean, Director, Nat'l Inst. of Dental Research, U.S.P.H.S., gave answers which can be briefly stated as follows: Critical analyses of the results of a large number of epidemiological and experimental laboratory investigations enable them to give "unqualified endorsement of the fluoridation of public water supplies as a mass procedure for reducing tooth decay by two-thirds." Toxicity of fluorine depends on its concentration; 1 ppm is well below any hazard level. Fluoridation is not medication; it does not cure, it simply prevents the initial development of dental decay. The policy of the U.S.P.H.S. is to recommend increasing the fluoride concentration to the optimal level of 1.0 ppm. Excessive amounts of fluoride cause mottled enamel; high concentration in a public water supply should be reduced by treatment or a new source of supply obtained.

H. Trendley Dean—"U.S.P.H.S. Position on Fluoridation of Public Water Supplies;" *Journal, American Water Works Ass'n*, September

AWWA Report On Water Rates

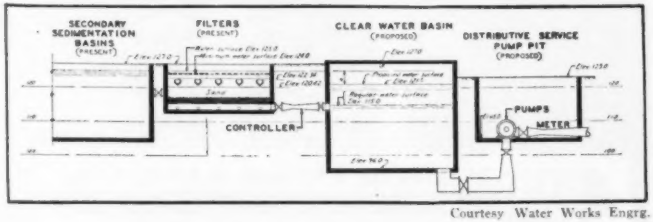
A Committee on Water Rates, appointed two years before by the A.W.W.A., reported its failure to agree on many of issues involved, saying "there are numerous controversies that are not likely to be resolved either quickly or to everyone's satisfaction." The controversies are considered in three groups: 1—The determination of the amount of revenue. 2—The allocation of revenue among rate payers and taxpayers. 3—The rate schedule or schedules for both normal and special users. Revenue may be determined on either the "utility" or the "cash" basis. On the utility basis, the gross revenue would include operation and maintenance expenses, taxes, depreciation, and rate of return on the rate base. On the cash basis, the total revenue is based on estimates of cash requirements supported by operating experience and knowledge of future needs. The basic items are operation and maintenance, debt requirements, replacements, and normal extensions and improvements; to which may be added taxes, appropriations for major improvements, and contributions to other city departments.

In allocation of revenue, serious consideration has been given to the propriety of collecting a large part of the total revenue from property for service rendered in addition to the water supplied, such as assessment for mains (not legally available to privately owned companies), and fire protection. The primary objective of a rate schedule is to distribute expense among customers in the most equitable possible proportion to the cost of supplying them with water, with due regard for simplicity in both classifying users and billing for service. There are special users (sprinkling, air conditioning, irrigation, etc.) whose maximum demand, in relation to average use, is higher than normal, to which consideration should be given.

"Water Rates: Committee Progress Report;" *Journal, American Water Works Ass'n*, September.

New Method of Filter Operation in St. Louis

A clear water basin and a distributive service pumping station are to be added to the Chain of Rocks Plant of the St. Louis, Mo., water works, and, as a result of studies and an experimental run at that city's Howard Bend Filter plant, these new units will be built so that the filter plant can be operated in a new manner. Instead of the clear water basin being designed for a water level 10 ft. below that of the filters, as at present, its walls will be built as high as the top of the filters, so that the entire



Courtesy Water Works Engrg.

● ***FLOW diagram, Chain of Rocks operation***

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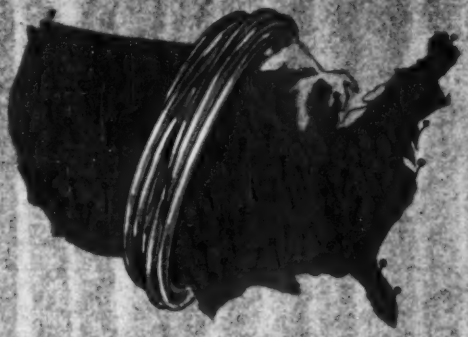

Within your easy reach there is a wholesaler willing to supply the materials you need and also provide helpful advice and cooperation to carry on your work.

Because many of the things you normally carry are in short supply and you are finding it difficult to meet the demands of your customers, it should be quite apparent that a closer relationship with your wholesaler can prove advantageous.

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purification system, including the filters, can float on the clear water basin. Each filter will be set to operate at its rated capacity, but the filters as a whole will deliver water at the rate at which it is being pumped. When the head lost through the filters reaches 4 ft. or less (instead of 8 ft., as at present), the filter operating at the lowest rate will be washed. The frequency of washing will depend on the rate of pumping and the clear water elevation to be maintained, which elevation (which determines the pumping head), should be the most economical balance between power cost and wash water cost. The advantages of this system are simplified operation, lower first cost, lower maintenance cost and lower pumping cost. The only thing the operator has to watch is the total head loss, which varies very slowly. The clear well can be made smaller, and a simple limit controller can be substituted for a rate controller.

E. E. Easterday—"New Ideas in Filter Operation Prove Economical at St. Louis;" *Water Works Engineering*, October.

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Protecting Valves From Air Attack

Denver, Colo., has under construction a concrete dam 340 ft. high from base of concrete to temporary crest, with provision for increasing the height to 460 ft. when increased consumption requires it. The reservoir will store 42,000 acre-feet at the 340-ft. level and 113,000 at 460 ft. Cooling coils for circulation of stream water will be set in layers every 5 ft. of height. Construction joints 50 ft. apart will provide for pressure grouting after the concrete has reached normal temperature. Four 42-in. outlets will be set in an 800-ft. diversion outlet tunnel, each outlet controlled by one operating and one reserve valve. These valves will be set in a vault with 225 ft. of vertical rock cover and 100 ft. of horizontal protection. Placing them in this protected chamber rather than in an exposed position will add $25,000 to the cost of this $11,000,000 structure, but is considered cheap protection against attack and against freezing.

"Controls to Go Underground at Denver Water Supply Dam;" *Engineering News-Record*, Oct. 18.

Removal of Radioisotopes

This paper reports the results, to May 1951, of studies sponsored by the U. S. Atomic Energy Commission. Many radioactive isotopes present in the waste products of fission or induced by neutron bombardment are chemically identical with elements encountered daily in food and water, and removal of a particular radioactive isotope would therefore require the removal of much larger quantities of the stable form of elements that have similar chemical properties. The most attractive measures of removing radioisotopes now being studied include evaporation, chemical coagulation or carrier precipitation, ion exchange resins and clays, and biological adsorptive or assimilation processes. Should a source of water supply be contaminated by radioactive materials, the most helpful precautionary measure to be taken by a rapid sand filter plant would be to coagulate and settle the water under the best possible conditions prior to filtration.

On the basis of the research conducted, several conclusions have been drawn:

1. Optimum removals of P^{31} and P^{32} result at conditions of good co-

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agulation, as evidenced by the rapid formation of large, easily settleable flocs and optimum turbidity removals.

2. High-exchange capacity clays improve phosphorus removals, particularly in waters that are low in alkalinity and total solids content. Such clays also increase the coagulant demand and broaden the range of coagulant dosages over which high efficiencies are possible.

3. Clays, including bentonite, will not bring about appreciable removals of P^{32} unless used in conjunction with hydrolyzing coagulants.

4. Multivalent cations such as Sr^{89} are best removed by coagulation processes that produce negatively charged floc. High-exchange capacity clays, lime-soda softening or phosphate-lime coagulation may accomplish this end depending on the degree of removal required.

5. Filtration efficiencies in removing radioactive phosphorus are closely allied to the degree of clarification achieved by coagulation and sedimentation. Orthophosphate is removed during filtration by the removal of the floc fraction passing the settling basin, rather than by direct adsorption on the sand particles.

Rolf Eliassen, Warren J. Kaufman, John B. Nesbett, and Morton I. Goldman—"Studies on Radioisotope Removal by Water Treatment Processes";—*Journal American Water Works Association*, August.

Operation of Commercial Departments

The average expenses of commercial departments of water works in southern cities are considerably more than those of northern cities. The average for all cities is 50% higher than in 1940, the cost per active service increased 37%, and per person served 40%. The lower expenses in the north is due largely to the fact that the billing periods are such that less than one-third as many bills are sent as in the south, but the average cost per bill in the north is twice that in the south. In 1940, 25% of bills were delivered by hand and 75% by mail, but in 1950 only 14% were by hand. In 1940 the stub system was used by the same number of departments as the ledger, but in 1950 the stub system was used by 57%. In 1940, 93% of the active services were metered; in 1950, 91%. The average cost per meter reading in 1950 was 16¢ compared with 4.4¢ in 1940. The average of northern cities was 34% higher than this and of southern cities 70% lower, because in the warmer climates meters are set in outside boxes and therefore more accessible. In 1940, 30.5% of the meters were customer-owned, but only 17.2% in 1950. In 1940, 88% of the departments bore the cost of meter repairs where damage is due to normal use, but 97% in 1950.

Kenneth K. King—"Meter Reading in Commercial Department Operation;" *Journal, American Water Works Ass'n*, September.

Analytical Instruments in Water Plant Laboratories

The author names and describes the various instruments used in waterworks laboratories, and their uses. In practically all water plants it is necessary to determine pH. Visual comparison of color with that of indicator solutions has long been common practice, but the color of glass discs is more permanent. A later development has been the electron tube pH meters using glass electrodes. Various forms of continuously indicating or recording

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pH meters are used by practically all large water plants. Conductance bridges are used to measure the amount of mineral solids dissolved in water. Photometers using either visual or photoelectric filters are suitable for a wide variety of colorimetric determinations, including those for alkalinity, iron, nitrite, nitrate, copper, lead, manganese, silica, fluoride and phosphate. A spectrophotometer can do the same with greater accuracy and reliability. The flame photometer is used chiefly for the determination of sodium and potassium, but also for lithium, calcium and magnesium. For testing for chlorine residuals, an amperometric procedure and instrument has been developed which rapidly measures both free and combined chlorine residuals. Automatic amperometric recorders are used in several plants. Automatic residual chlorine controllers are used by several cities, but are not available commercially as complete units. The spectrograph if used by a well-trained operator can be used to determine extremely small quantities of many of the elements commonly found in water. Other instruments described are analytical balance, turbidimeter, electron microscope, polarograph, monitors for detecting and measuring radioactivity in water. There is a growing trend toward the use of automatic and semiautomatic instruments; a recent example of which is the automatic titrator. The author gave the market prices in May 1951 of the more commonly used of these instruments and the names of manufacturers of them.

S. K. Love—"Analytical Instruments Used in the Modern Water Plant Laboratory;" *Journal, American Water Works Ass'n*, September.

Lessons from The Kansas Flood

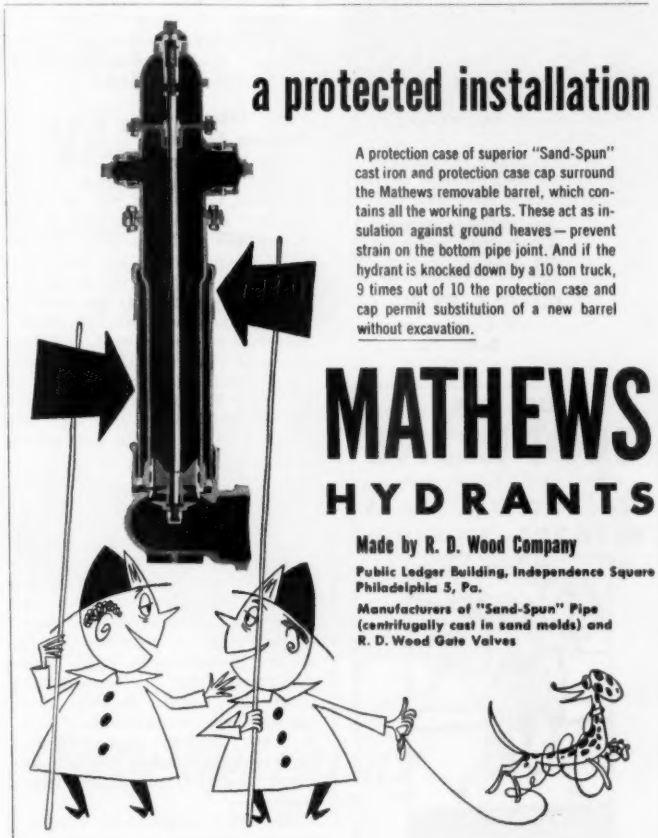
A study of the effects of the recent Kansas flood on the nearly fifty water supplies affected leads to three suggestions: 1—A very large number of plants were crippled by power failures; the entire matter of power supply and auxiliary power for emergencies will bear a great deal of investigation. 2—Elevated storage proved to be valuable to many communities that were unable to keep their systems in operation. 3—The fact that so many water plants and clear wells, which could have been built out of the river valleys for a small additional cost, were under 5 to 10 feet of water suggests that designing engineers and regulatory bodies responsible for approving water works plans may want to reexamine their plant location policies.

"Water Supply Notes on the Kansas Flood;" *Journal, American Water Works Ass'n*, September.

Use of Copper with Ammonia and Chlorine

The idea seems to be more or less generally prevalent that the ingestion of copper is injurious to human beings, but this is not true for reasonable amounts. For example, cow's milk contains 0.5 ppm of copper. The human body requires at least 2 mg of copper per day.

In Richmond, Va., water that has been through the filtration plant goes to an open reservoir, where algae developed abundantly. The application of chloramines only partly relieved this condition. Use of copper sulfate in the finished water was opposed for fear of copper poisoning, but the state department of health, after thorough consideration, approved the use of copper sulfate in quantities sufficient to cause approximately 0.2 ppm of copper to be present in the distribu-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tion system. After some preliminary difficulties in regulating the application of copper sulfate with ammonia and chlorine, the algae in the reservoir were eliminated completely and the mains cleaned of deposits. During the experimental period it was learned that the effectiveness of copper and ammonia and chlorine was much greater when used in combination than when used separately, suggesting the formation of a chemical complex that may be called cuprichloramine. Complete algae control by this method costs not more than 16¢ per m.g.

Marsden C. Smith—"Copper with Ammonia and Chlorine in Finished Water;" *Journal, American Water Works Ass'n*, September.

Plant for Feeding Fluoride

The equipment most suitable for feeding fluoride depends on the chemical to be fed, size of plant, whether or not the supply is enclosed and under pressure at the point of application, the number of application points, cost of the chemical, and whether for an existing plant or for a new one. The chemicals most commonly used, and their prices as of June 1951 are: Sodium silicofluoride, 9.33 cts per lb. of available F. Sodium fluoride, 25.0 cts. Hydrofluosilicic acid, 32.9 cts. There is none of the last named available at present; and a temporary shortage of silicofluoride. For pumping the acid, rubber or plastic diaphragm type proportioning pump is recommended. For dry feeding, a feeder on a platform scale, or a gravimetric weighing feeder, with dissolver, delivering by gravity or by injector or pump against pressure; or saturators for sodium fluoride, with liquid feeder for gravity feed, or proportioning pumps for pressure feeding. There are four basic requirements of feeders for fluoride chemicals—Accuracy, dosage check, efficient dissolver, and protection against overfeeding.

The most satisfactory pipe for fluoride solutions is rubber hose; several plastics are available, but none has been in use for more than five years. Scaling or clogging of pipes and equipment may be expected if hard water is used to convey the fluoride solution. This can be prevented by treating the water with Calgon, Micromet or Nalco 918; or by using a softener. Fluoride should not be applied to water with or before coagulants or softening chemicals; the conventional application point is in filter effluent lines or in the clear well.

L. E. Harper—"Fluoride Chemical Feeding;" *Journal, American Water Works Ass'n*, September.

Cost of Meter Maintenance

Answers to 40 of 56 questionnaires sent to the U. S. cities of from 100,000 to 200,000 population form the basis of a summary by the author of the costs of the several items of meter maintenance. These he compares with the results of a similar questionnaire sent in 1941. Of the 40 cities, 30 test all new meters; 19 require an accuracy of 90.0-102.0% at a rate of ¼ gpm; the others vary in their requirement from movement at ⅛ gpm, to 90.0-98.0% accuracy at 8-20 gpm. Meters are removed for testing by 12 cities after having registered a certain amount of water, and by 22 after having been in service a certain period of time. The lowest flow at which they are tested is ¼ gpm in 19 cities; 0.8-2 in 6 cities; 3-5 in 2 cities. All meters brought to the shop are completely dissembled by 29 cities. In cleaning the disc chamber, 37 cities use abrasives, such as brush, scraper, steel wool, emery cloth or sand paper; 14 of them without a solvent, 23 plus some solvent; while 3 use solvent only. Registers are usually found in need of repair by 27 cities, occasionally by 3. Gear trains are repaired by putting in individual gears when this is practicable, rather than by putting in complete new trains. Repairing a meter is considered uneconomical by 16 of 23 cities replying when the cost of repair parts, or both labor and repair parts, equals 50 to 75% of the cost of a new meter. Of the 40 cities replying, 27 are completely metered, and only 6 are less than 90% metered.

A. P. Kuranz—"Meter Maintenance Costs;" *Journal, American Water Works Ass'n*, September.

Locating a Sub-aqueous Leak

A new raw water intake line for the city of Wyandotte, Mich., consists of 1700 ft. of 42" concrete pipe laid in a trench 12 ft. below the bottom of the Detroit river. On completion, but before the trench had been backfilled, it was tested for leakage under a head of 15 ft. above river level. Leakage totaled only 1 gpm, while specifications al-

lowed 17 gpm. A head of 20 ft. was maintained during backfilling, but when 800 ft. of the trench had been backfilled a leak developed exceeding 1,000 gpm. To locate the leak, water was pumped into the pipe and carbon was added to it at the rate of 150 ppm. Men in two boats could find no sign of the carbon escaping into the river water. Use of a fluorescine dye at 2 ppm was equally ineffective. Adding chlorine at 28 ppm and testing the river water along the pipe line with orthotolidine was unsuccessful. Other methods also were tried. Success was obtained by locating brine leakage into the river through the leak by means of a Type 650-A impedance bridge made by General Radio Corporation. A cell containing two insulated nickel wires connected to the impedance bridge by 50 ft. wires was lowered into the river and moved along the pipe. Where brine leaked into the river it caused a sharp deflection of the pointer. Thus the exact location of the leak was determined, it was uncovered and found to be a joint which had pulled apart about 2" at the widest point.

George Hazey—"Leak Detection on Subaqueous Raw Water Intake Line;" *Water and Sewage Works*, September.

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Improved Coagulation by the Use of Pulverized Limestone. By *Charles H. Spaulding, Harry N. Lowe, Jr.* and *Richard F. Schmitt,* Engr. Research & Development Labs. October, Pp. 793-802.

Geologic and Hydrologic Factors Affecting Perennial Yield of Aquifers. By *V. T. Stringfield* and *H. H. Cooper, Jr.,* U. S. Geological Survey. October, Pp. 803-816.

Geologic and Hydrologic Factors in the Perennial Yield of Biscayne Aquifer. By *Garald G. Parker,* U. S. Geological Survey. October, Pp. 817-835.

The Organic Nitrogen Problem. By *D. B. Williams,* W. W. Lab., Brantford, Ont. Oct., Pp. 837-846.

The Breakpoint in Bromination. By *Marcy Brooke,* Phillips Oil Co. October, Pp. 847-848.

Tentative Standard Specifications for Reinforced Concrete Water Pipe—Noncylinder Type, Not Prestressed. October, Pp. 851-864.

Engineering News-Record

Controls to Go Underground at Denver Water Supply Dam. Oct. 18, Pp. 47-48.

Public Works

Redesigning a Cathodic Protection System for an Elevated Tank. By *Henry J. Graeser,* Asst. Supt. Water Dept., and *Ed. R. Walker,* Sup. of Pumping, Dallas, Tex. November, Pp. 36-39, 74.

Vertical Turbine Pump Application in Water Supply Systems. By *R. H. Bird,* Peerless Pump Div. November, Pp. 48-50, 62.

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Résumé des Etudes sur le Comportment des Tuyauteries en Plomb et Alliage de Plomb. Committee report of K.I.W.A. October, Pp. 27-29, 40.

Water Works Engineering

New Aqueduct Provides Large Supply for Salt Lake Area. October, Pp. 966-969.

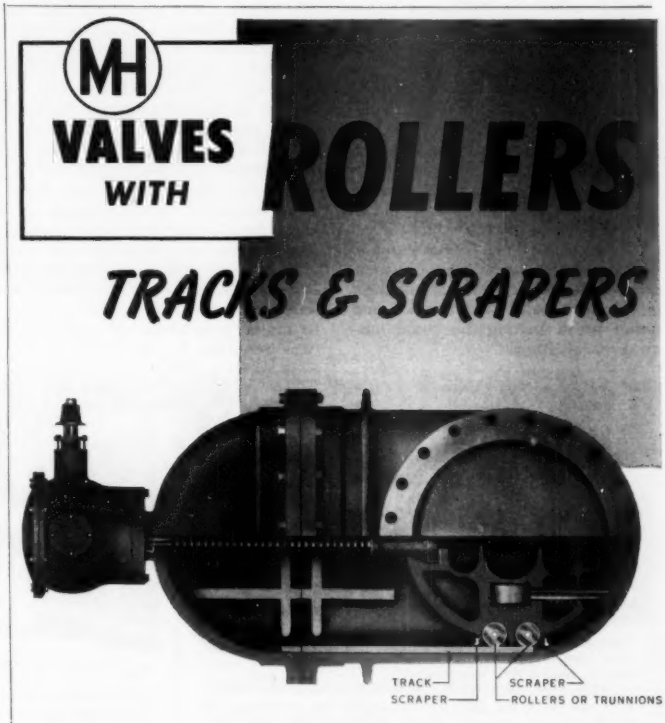
New Ideas in Filter Operation Prove Economical at St. Louis. By *E. E. Easterday,* Chf. Engr., Water Div. October, Pp. 973-974.

• • •

Solving A Golf Course Water Supply Problem

The Belvedere Country Club, Hot Springs National Park, Ark., is located on rolling flint-rock terrain, so that excavation for a water supply system would have been costly and difficult. Instead, Carlon flexible pipe was used. One furrow was turned up with a plow. and this was sufficiently deep to accommodate this plastic pipe. Couplings were also plastic. After placing the pipe, the sod was laid back in the furrow and rolled.

Because the coefficient of expansion of this pipe exceeds that of water converted to ice, precautions against freezing are not necessary as the pipe will not burst. Also, its flexibility permits following any kind of a trench line or surface profile.



Easy operating

To avoid undue wear of moving parts when installed in horizontal position, large size M & H double disc gate valves may be ordered equipped with rollers or, rollers, tracks and scrapers. This is recommended when large valves are installed on their side and the heavy weight of the gate assembly creates a drag on the underside where it rests on the body. Rollers, tracks and scrapers make the heavy gate assembly easy to open and close, reduces wear and possible damage to the disc rings or the seat rings. For complete information, write or wire M & H Valve and Fittings Company, Anniston, Alabama.

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Membrane Filter Technique for Water Bacteriology

Information on the membrane filter has been released by the Public Health Service. Systematic and controlled experiments with this filter at the Environmental Health Center at Cincinnati have demonstrated exceptional accuracy in identifying and counting bacterial colonies with far-reaching economies in time, labor, space and equipment.

The use of this filter cuts down the time of analysis from a period of days to a period of hours. It reduces the number of operations needed for bacterial analysis. It makes it practical to take samplings of water many times larger than those employed by prevailing techniques. And it requires far less laboratory space and equipment. However, there is still much work to be done to establish and develop the full range of practical applications of this laboratory tool.

The apparatus is so simple and so readily portable that bacteriologists may find it possible to extend their services to rural communities and other areas lacking the usual laboratory facilities.

Although membrane filters have been familiar to research workers for many years, the techniques developed at the Environmental Health Center suggest the possibility of their practical widespread use. The cost of bacterial tests using the filters will be much less than by procedures presently used.

Each filter is a disc about 0.1 mm. thick and 48 mm. in diameter, or about the size of a silver dollar. The pores are regularly spaced and vertical, tapering toward the upper end. The size of the pores may be varied in manufacture. Filters with the larger pores permit the passage of approximately a quart of water at a pressure of one atmosphere in less than a minute. A filter with the smallest pores require 100 minutes for the passage of the water. No bacteria pass through the filter, although viruses may get through.

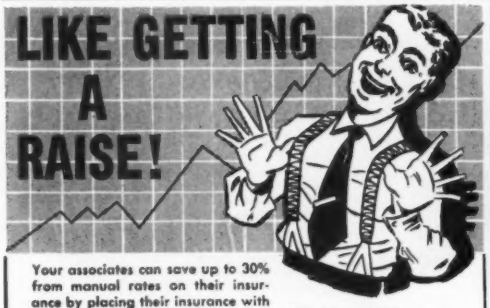
After bacteria are trapped on the filter, the disc is placed in a Petri dish against a medium which encourages the growth of the organisms under investigation and simultaneously represses the growth of other organisms. The development of appropriate culture media, a major task of the investigation, was reported by Harold F. Clark, Edwin E. Geldreich, Harold L. Jeter and Paul W. Kabler. Media which are suited to other methods of bacterial analysis are not necessarily suited to work with the filter.

With the filter, it is possible to entrap, cultivate, and identify typhoid germs with an ease that contrasts strikingly with the difficulty experienced with analysis by other methods.

• • •

Pest Control in A Southern City

The pest control department of Jackson, Miss., used 35,000 gals. of DDT solution in 1950 in its program to combat flies and mosquitoes. Biweekly treatment of the entire city with fog applicators kept the adult fly and mosquito population to a minimum. Weekly larviciding of water breeding areas destroyed larvae. Also, 400,000 cups of ant poison were placed and every home where rat infestation was evident was treated. Red squill was the principal poison, 10,000 pounds being used; and 400 permanent-type poisoned water dispensers were installed in business establishments. The cost of this program was 55 cents per person for the year.



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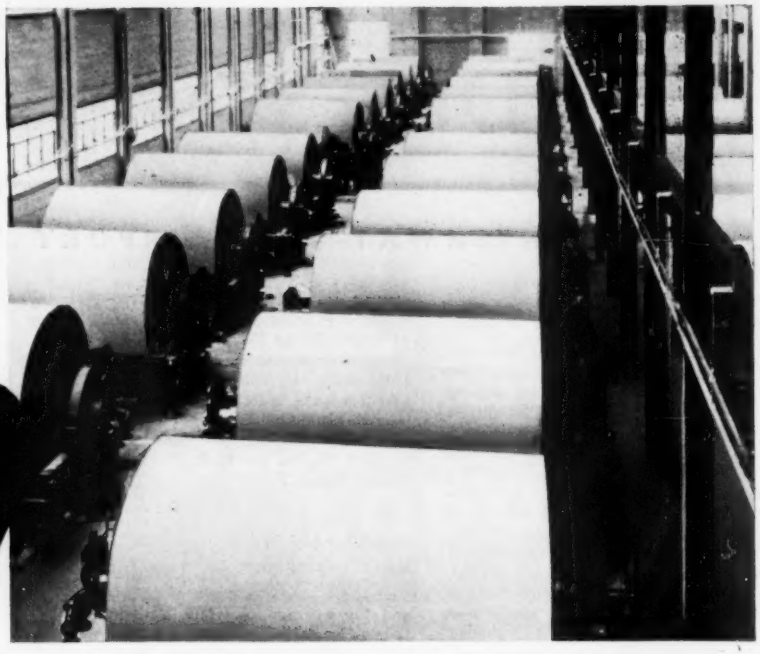

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66 Conkey Sludge Filters now installed in one plant of Chicago Sanitary District

The West-Southwest Treatment Works of the Chicago Sanitary District is the largest sewage treatment plant in the world. Here, the huge volume of industrial and residential waste from the heavily populated metropolitan area has presented sewage engineers with an unparalleled challenge. Progressively, the Chicago Sanitary District has met that challenge. Starting twenty years ago with installations of continuous vacuum filters for activated sludge, Sanitary District engineers have developed the most exacting specifications and rigid requirements for filter designs and performance . . . culminating in the installation of 66 Conkey Rotary Drum Vacuum Filters for this largest single installation in the sewage field.

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Warped Slopes On Idaho Roads

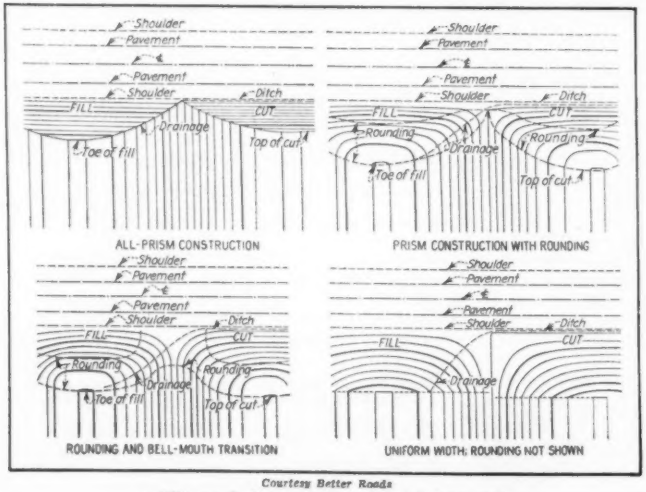
Shaping roadside slopes in a natural manner during construction eliminates the necessity of waiting for nature to break down the angles, reduces the amount of erosion, hastens the permanent establishment of native vegetation, and thus reduces maintenance costs. Air currents tend to flow more uniformly around a well-rounded warped cut, thus minimizing snow accumulation on the road. Sight distances are increased, and overturning of vehicles that leave the road is made less probable. Numerous types of warped cut and fill slopes have been proposed, such as the prism type with rounding at the beginning and ending of cut and fill slopes; and the "bell-mouth" transition. A simpler method, known as the "uniform width" plan, is now standard in Idaho. This consists essentially of using the maximum depth of a cut or height of a fill to determine a constant distance from the center to all slope stakes throughout that cut or fill. This distance is determined by using the standard rate of slope—2:1 or 2½:1 or other—for the maximum cut or fill. No other slope stake calculation is necessary, and if a stake is lost it is easily replaced.

W. H. Marcellus — "Simplified Warped Slopes in Idaho;" *Better Roads*, October.

Snow Control in Upper Michigan

In the Upper Peninsula of Michigan the average snowfall is about 160 inches; last year is was 286 inches. Snow drifts of 10 to 20 ft. are common. A whole village street is often buried in snow to the second story windows. During severe storms no effort is made by Houghton County to open secondary roads until after the 212 miles of trunk lines have been cleared. The county operates 26 5-ton to 10-ton trucks, 8 Sno Go's, a Roto-wing, 2 Snow Kings, and a few smaller units. All trucks are equipped with 12-ft. wings, and after a light snow can clean a path 15 ft. or more wide. The county uses approximately 300,000 ft. of 4-ft. picket fence. In very bad places the posts are heavier and longer and an 8-ft. fence is made by superimposing a second 4-ft. fence above the bottom row. In some cases a two-row fence is hung between permanent cedar posts supported by ½ in. cables. In extreme conditions, fences 12 to 16 ft. high are built of pine boards. All 4-ft. fences are raised after the first few storms have completely buried them. Snow mat is prevented from forming on the pavements by keeping the cutting edges of the plows close to the road and carrying very little of the weight of the plow on the runners or on the truck itself,, and completely removing the snow periodically by patrol graders. An ideal outfit would include various weights of equipment, from light trucks with one-way plows to the heaviest; but if this is financially impracticable, the heaviest can do light work but the light equipment cannot do heavy work. Rotaries are strongly recommended for heavy snows.

C. F. Winkler—"Where Snow Removal Is Toughest;" *American City*, October.



Courtesy Better Roads

● ***Warped slope designs for Idaho roads.***

Paved Shoulders On Nevada's Highways

Nevada has, for the past 15 years, been providing either roadmix or plantmix bituminous shoulders, generally ranging from 2 to 2½ thick, on all construction and reconstruction projects. The advantages of paved shoulders include: 1—Reduction of maintenance work, such as building up shoulders, blading shoulders and weed cutting; only a flush seal coat of asphalt every 7 or 8 years. 2—Safety to the traveling public—there are no soft or depressed shoulders. 3—No washing away with rain runoff of overflowing streams. (In November 1950,

rivers flooded highways on fills to depths up to 3 or 4 ft., without damage to the paved shoulders). 4—Shoulder-to-shoulder surfacing helps to prevent seepage of moisture under the pavement edge. In building up 2-ft. shoulders, Nevada uses a 2½-yd. dump truck loaded with cinders or screenings, which are dumped into a 2-ft. spreader box, with a strike-off blade and a 3-nozzle spray bar in front of it. This truck tows a trailer-type 250-gal. oil distributor and, back of this, a tow-type roller. These lay about ¾ in. of oiled material.

J. D. Meacham—"Shoulder Paving Serves Several Purposes;" *Roads and Streets*, September.

Bituminous Resurfacing On Illinois Highways

The Illinois Div. of Highways has developed an adaptation of bituminous resurfacing of old pavements which it calls "overlays." The predominant mileage of the state highway system was paved with portland cement concrete. These were repaired with concrete; but as repaired areas had to be closed to traffic for several days, these inconvenienced traffic seriously. Overlays can be opened to traffic immediately; and also are cheaper when the repaired area is more than 8 to 10 ft. long in both lanes of a two-lane pavement, or 15 to 20 ft. long in a single lane. A 3-in. depth is recommended and generally used where mud pumping or other unfavorable conditions prevail, and for pavements that have a fair remaining life but have failed in local areas. Overlays 1½ thick are used where the surface has disintegrated and if the pavement is programmed for complete resurfacing in the near future. Overlays are not used on pavements having a long remaining life and a few scattered failures per mile.

C. W. Ross—"Use of Bituminous Overlays Found Economical in Illinois;" *Better Roads*, September.

Well Balanced Maintenance Equipment

In the ideally balanced highway maintenance equipment fleet, there should be enough units of suitable types to perform economically the maximum amount of the work involved in providing full maintenance of the highway system served; and the annual cost should be reasonable or justifiable. These objectives are never fully attained and the equipment needed therefore varies in different states. Some of the most significant factors in determining major equipment needs are: mileage of roads by type of surface, climate, topography, soils, characteristics of the road system, availability of materials and of private equipment, number and type of structures, jurisdictional factors and prevailing management policies. An analysis of the equipment fleet of two state highway departments shows the number per 1,000 miles of highway maintained to be as follows: Trucks, 54; displacement-type snow plows, 32; automobiles, 23; tractors, 16; tow-type graders, 15; motor graders, 11; mowers, 13; spreaders, 13; kettle-type heaters, 12; rollers, 6; loaders, mixers and trailers, 4 of each; air compressors, bituminous distributors, pumps, 3 of each; scrapers, power shovels and cranes, and sweepers, 2 of each; and one bulldozer, crushing plant and welder.

Illustrating the effect of climate on equipment, a southern state requires less snow handling equipment than a northern, and more mowing equipment because weeds grow more rapidly and for a longer season; greater rainfall or more

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erodable soils require more frequent ditch cleaning. Mountainous topography causes slides which necessitate heavy earth-moving equipment, and less mowing is required because of narrower rights-of-way, and more hand mowing because of steep slopes, guard rails and boulders. Heavy traffic makes more prompt and rapid patching necessary, and the use of distributor spray bars that seal-coats only one-half the width of road, while where the traffic is light the whole width can be covered with one trip. Availability of local aggregates calls for crushing and screening equipment unless the state buys them.

H. A. Radzikowski— Balancing a Maintenance Fleet;" *Better Roads*, October.

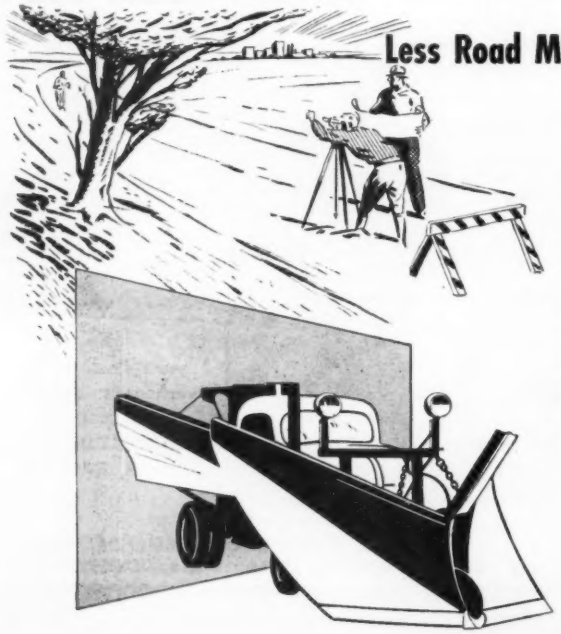
Building Embankment Across a Reservoir

California is constructing a highway of which an important feature is the crossing of a reservoir site by two fills, the larger of which is 1100 ft. long, with a maximum height of 140 ft. and maximum base width of 1,000 ft. This divides the reservoir into two parts, which are connected by a 10 ft. concrete conduit 90 ft. below the roadway and an emergency conduit of 120-in. steel pipe 22 ft. below the roadway. Loose soil below the embankment is removed to a depth of 10 ft. Benches 60 ft. wide are provided at 50-ft. vertical intervals down the fill slopes. The fills will be protected against wave action by rip-rap of rock taken from cuts at other points of the highway construction. Fill materials vary from a soft, brown, clayey shale to a soft sandstone, deposited in 6 in. to 8 in. lifts. Compaction to 95% maximum density is required, 90% being obtained by use of tamping rollers, and the additional 5% by use of 40-ton pneumatic-tired rollers, with not less than 10 tons to a tire, which are inflated to not less than 60 psi pressure. A bulldozer mounted on the lead unit of 3 compactors makes a smooth operating bed for them.

"40-Ton Compactors Specified for First Time on California Road Job;" *Roads and Streets*, October.

Renewing Asphalt On a Heavy-Traffic Street

Fort St., Detroit, carries a daily average of 42,000 vehicles, 21.8% of which are trucks. Its pavement of sheet asphalt on concrete base had deteriorated during post-war years, and abandoned street railway tracks added to the desirability of resurfacing. A contract was let last July for resurfacing about 5 miles of 72 to 80-ft. pavement to a contractor who sublet about half of it. The work was to be done in 11 weeks and was actually completed in 5, without any detouring or delaying of traffic. Over 1400 manholes, catchbasins, public service boxes, etc. were raised, using high-early-strength concrete for resetting, mostly by night work. All asphalt placing was done after work hours. By 6:30 or 7 binder course material arrived on the job and was laid on a running lane 1600 to 2600 ft. long, which had already been broomed clean and covered with a bond coat of asphalt emulsion. Using one paver, two 10-ton tandem rollers and the necessary trucks, each contractor usually covered half or more of the street width for the work section in one night, placing an average of 600 to 650 tons, by 5 or 6 A.M. Traffic was allowed on each course immediately after final rolling and by cooling with water spray. Placement of the surface course took place at intervals when the raising crews had cleaned up a



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sufficient length of street to give a good paver run. The two courses of hot mix totaled about 3 in. minimum thickness.

"World's Busiest Industrial Street Repaved as High Speed Night Job;" *Roads and Streets*, October.

Snow Handling On Schenectady's Streets

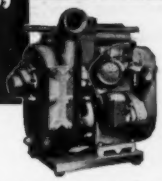
In Schenectady, N. Y., last winter, trucks with salt spreaders were sent out immediately at the start of a snowfall, keeping the main routes clear of light falls of snow and making plowing much more efficient when it was used. Five city-owned and operated graders and 20 private trucks equipped with city-owned plows were used. These all started when the snowfall exceeded 2 in. As soon as the snow stopped falling, snow was removed completely from the downtown streets and from narrow streets; plowing the snow into windrows with graders and loading it into trucks with five Sno-Go's, or, if wet or heavy, with a Nelson Loader and 2 Barber-Greene loaders. Previous to snow removal, signs were erected on parking meters or elsewhere, with the caption "No Parking—Snow Removal—after—P.M.", naming an hour—3, 6 or 11, most frequently 11.

John F. Lucey — "Less Work Moves More Snow;" *American City*, October.

Traffic Accidents on Limited-Access Highways

The accident rate and severity on the Pennsylvania Turnpike has risen so high that one large trucking company has discontinued use of it. There is no general agreement as to why. Some believe it is caused by drowsiness induced by the monotony of driving on a road free of physical hazards, but truck operators lay it to speeds above the driver's capacity to control his vehicle properly. The author believes that the disconcerting record made by the Pennsylvania Turnpike is due primarily to failure to appreciate that higher speeds call for more complete traffic control—lower speed limits and more traffic police. Some attribute the accidents to design features, one of these being the flat and narrow (10 ft.) median zone. Painting a 4-in. white line surfaced with reflective material along the edge of the pavement next to the median zone has been recommended. To reduce drowsiness due to monotonous driving, the

Jaeger 60 lb. "Bantam" armored against wear



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New Jersey Turnpike avoided long tangents, and considered using concrete and bituminous pavements on alternate sections.. On the Taconic Parkway, east and westbound lanes are placed at different levels where the topography permits. Frequent varying of the distance between east and westbound lanes and erecting a variety of signs at frequent intervals are among other suggestions.

V. T. Boughton—"Are Toll Highways Accident Breeders?;" *Engineering-News-Record*, Oct. 18.

Economy in Maintenance Service

Minnesota Highway Dept. offsets increased costs of maintenance by use of power tools— scythes, saws, tamping devices, small tractor loaders, etc. It finds that a small two or three-man crew is often more economical than a big motorized gang. To avoid over-organization of equipment and personnel, Minnesota does seasonal work by contract wherever possible; roadside mowing is performed by farmers (by growing suitable grass on the shoulders, farmers are glad to mow them for the hay); winter maintenance is facilitated by use of contractors' equipment which is idle during winter months; graders, bulldozers, etc. can be rented on an hourly basis. Construction of highways with streamlined cross-sections and high grade-lines has reduced the cost of snow removal, and of snow fence and guard rails. *C. L. Motl.*

Texas Highway Dept. finds that proper equipment and performance of heavy maintenance on a project basis affords the key to rapid expansion of operations at a minimum cost. Their crews, equipped with the best trucks, loaders, maintainers and rollers that they can provide, are able to cover heavier work and additional mileage. The old 1½-ton trucks are being replaced with 2½-ton. Each maintenance crew in the 25 districts is assigned loading equipment, with truck-mounted and track-type draglines for heavy work. Three and 4-ton maintenance rollers with built-in travel wheels are replacing lighter units; and 18,000 and 21,000 lb. maintainers are replacing the old 14,000 lb. machines. The department's investment in equipment is five times that of 12 yr. ago.

The greatest advantage in performance of heavy maintenance on a project basis is the greater quantity of work that can be done. Many projects are placed under contract; on others, the department's maintenance crews are used, generally supplemented by leased equipment, with operators, for such work as the department does not have men or equipment available for; thus handling such projects with minimum disruption of the maintenance organization. *P. S. Bailey.*

"Curb on Upkeep Outlay;" *Better Roads*, October.

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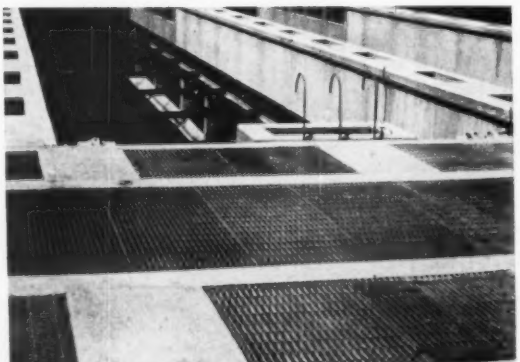

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Detroit Street Name Signs Always Bright. By *Frank A. Ronan*, Sr. Asst. Traffic Engr. October, Pp. 141, 143.

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Power Tools, Small Crews and Rented Machine All Helpful. By *C. L. Motl*, Maint. Engr., Minn. Dept. of H'ways. October, Pp. 25-26.

Balanced Maintenance Policy Saves Money for Mississippi. By *F. J. Russell*, Engr. of Maint., Miss. H'way Dept. October, Pp. 26-28.

Proper Equipment for the Job Expands Maintenance Capacity. By *P. S. Bailey*, Maint. Engr., Texas H'way. Dept. October, Pp. 28, 44

Simplified Warped Slopes in Idaho. By *W. H. Marcellus*, Asst. Plans Engr., Idaho Dept. of H'ways. October, Pp. 29-30.

Balancing a Maintenance Fleet. By *H. A. Radzikowski*, Chf. Maint. Branch, B.P.R. October, Pp. 31-34, 38.

Why Modern Road Programs Have Stalled. By *C. Coykendall*, Sec. Iowa Good Roads Ass'n. October, Pp. 37-38.

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New Jersey Toll Road is Rushed to Completion. By *Henry T. Perez*, Assoc. Editor. October, Pp. 48-51.

Engineering News-Record

Are Toll Highways Accident Breeders? By *V. T. Boughton*, Assoc. Editor. Oct. 18, Pp. 30-33.

Strengthening Navy Airfields for Jets. Oct. 18, Pp. 41-42.

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Pavement Design for Roads and Airfields. November, Pp. 40-42, 54.

Laying a Double Bituminous Surface. By W. T. Reid, November, Pp. 31-32.

Extension Blade Cutter for Motor Grader. By T. J. Fricke, November, P. 33.

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Performance of Airport Pavements. By *Henry Aaron*, Chf. Paving & Soils, U. S. Civ. Aeronautics Admin. September, Pp. 78, 80.

Methods and Application Procedures for Pavement Marking. By *Charles R. Waters*, Dist. Engr., N. Y. State Dept. of Pub. Wks. September, Pp. 82, 84, 86, 94, 96

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How a Texas District Has Improved Its Arphaltic Seal Coats. By *J. C. Robert*, District Engr., Texas H'way Dept. October, Pp. 70-75.

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Precasting of Highway Bridge Floors

An abstract of a paper before the 13th Annual Meeting of the Highway Research Board by R. B. McMinn, Senior Highway Bridge Engineer, Bureau of Public Roads, Portland, Oregon

PRIOR to 1948 the precasting of highway bridges consisted principally of precasting units, complete in themselves, which when placed or assembled constituted a complete span. Later developments with respect to bridges consist of two different systems of precasting. The first system consists of combining precast stringers with cast-in-place floor slabs, thus resulting in Tee beam spans. This system has been employed in bridges constructed at Lowell, Mass., with spans up to 55 ft.; and in 800 linear ft. of trestle approach to the South Yamhill River bridge in Oregon. The second system is described as consisting of the field assembly of precast beams or stringers and floor slab panels separately, which, when assembled, are welded together with concrete to form an integral structure.

One of the most important advantages of precasting bridge decks is the speed of construction. With a single shift and a very small crew of men, a trestle span can be completed in one day if the stringers and slabs are cast in advance. In case of emergency projects the time required could be greatly reduced. This factor, combined with the fact that precast members can be placed on one half of the roadway at a time, is particularly important where traffic must be maintained.

The elimination of a large percentage of "on the job" labor through the use of precasting should not be overlooked. The precast members can be made a considerable distance from the site of the bridge where there is a good labor supply and where a readymix plant or material supply is available. This is particularly important on isolated jobs, inasmuch as it is difficult to get men to go to such jobs, and if they do go out the cost of labor may be increased as much as 50 percent because of additional travel, subsistence and bonus costs.

Advantages from the use of precast members are summarized as follows:

1. Savings in forms, falsework and placing of concrete.
2. Elimination of a large amount of "on-the-job labor."
3. Speed of erection.
4. Easier maintenance of traffic.
5. A central plant operation permits closer control of concrete mixture, placing and curing, resulting in a better construction job.
6. In regions where the construction season is short, precasting can be done during the winter season under cover and thus expedite construction.

In preparing specifications with a view to contracting precasting work, the precision required for casting should be specified, with definite tolerance set for variations in straightness, size and length.

For rectangular beams, it should be specified that they be kept in an upright position from the time they are cast until they are placed (unless handling stresses are satisfied for other positions).

It is recommended that eyebolts or methods for handling with slings be provided on the plans or in the specifications. Preferably, more longitudinal steel should be placed in the top of beams than required for temperature or spacer bars, in order to provide for handling stresses.

Precast members should be designed to:

A. Simplify form work so that it can be readily removed and reused.

B. Facilitate the placing and finishing of the concrete.

C. Provide for ease and safety in handling.

The use of an air-entraining agent is recommended for all concrete in precast members for the following reasons:

A. To improve the workability of the concrete.

B. To increase the resistance of the concrete to freezing and thawing.

Vibration of the concrete in precast members is considered to be essential, and it is believed to be common practice.

Consideration should be given to the use of lightweight aggregate for beams, in order to:

A. Reduce the dead load, thus effecting a saving in steel and concrete.

B. By reducing the dead load, increase the length of spans considered feasible to precast.

C. Reduce the load, so that the beams can be more easily handled, transported and placed.

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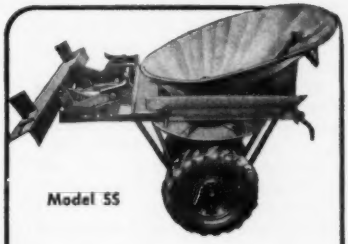

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Pittsburgh Salt Boxes Speed Snow Removal

To help get a quick start on snow and ice removal work many cities put boxes of coarse rock salt at strategic intersections and hills throughout the city and invite motorists, service station attendants and others to spread the rock salt on danger spots until the regular crews come along.

The idea, tried out in Pittsburgh last winter, worked very well there, according to Public Works Director James S. Devlin. "The boxes are a big help," he said. "It's a lot faster than waiting for trucks to make the rounds, and it also keeps expenses down." Spreading rock salt as soon as a snow or sleet storm starts reduces the cost of keeping streets snow and ice free, because the salt prevents the fall from packing and freezing to the streets.

Mr. Devlin placed 40 boxes on Pittsburgh's North Side last year and 20 in the East End district. Each box has the word SALT painted on it in 15-inch letters, and inside each one, lying on top of the coarse rock salt, there is a short handled shovel to use in spreading it on the streets. Throughout last winter in Pittsburgh there were no reports of wastefulness in using the coarse rock salt.

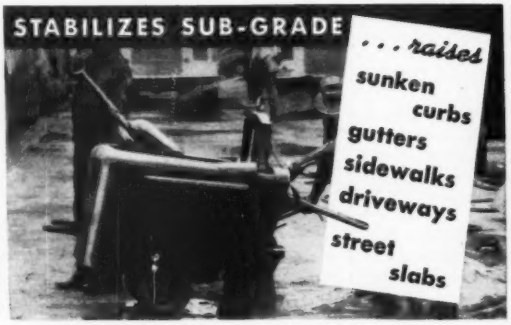
In addition to putting out the boxes and keeping them filled, Mr. Devlin explained that it is important to keep telling the public, through stories in local papers, that the rock salt is there for their use. Otherwise, many people think that the rock salt boxes are maintained for the regular snow removal crews and do nothing about spreading the salt themselves as they need it. The plan has worked so well in Pittsburgh that Mr. Devlin is planning to increase the number of such boxes in the coming months.

• • •

Modern Street Oiling Practices

With the continued increase in street mileage over the past years, it became necessary for the Lewiston, Ida., Street Department to modernize its maintenance program. A study of methods used in other similar communities led to the conclusion that the most expeditious and economical method of maintaining streets is for the City to own the equipment and do the work. Recognizing the advantages of such a program, the City Council authorized, during the past year, the purchase of some $17,600 worth of equipment to be used in oiling streets. Included were the following items: A 10,000-gallon electrically heated road oil storage tank, a 1,000-gallon asphalt distributor; double-deck vibrating sand screen; two-compartment sand bunker; a 60-foot gravel conveyor; a gravel spreader; and a 2-ton 3-yard dump truck. The equipment was obtained in time for the completion of several oiling projects last summer, which, together with the work done this past season, amounted to 3.25 miles of streets graded and oiled with MC-2. The equipment has also been used in making up road mix material for use in patching street surfaces. One of the prime advantages in the City doing street oiling lies in the fact that the work can be done when it is needed rather than waiting for a contractor to come in and do the work.

These data are from the annual report of W. P. Hughes, City Engineer of Lewiston.



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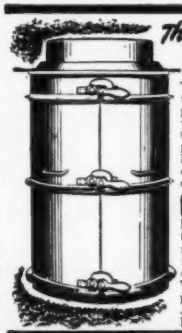

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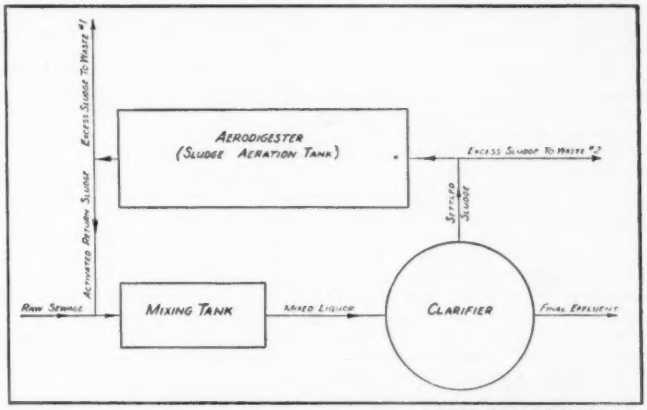
PUBLIC WORKS DIGESTS

THE SEWERAGE AND REFUSE DIGEST

The Biosorption Process Explained

The Biosorption process, developed in 1950 at the Austin, Tex. treatment plant, is essentially a high-rate activated sludge treatment process. Activated sludge is mixed with raw sewage, and adsorbs and absorbs a very high percentage of both the suspended solids and dissolved pollutional material. The mixed liquor then flows to a clarifier, where it is settled, leaving a supernatant that is clear, low in BOD and in suspended solids and in the plant effluent. The sludge now contains the original activated sludge plus the suspended and dissolved matter adsorbed and absorbed from the raw sewage, and is conducted to an aeration compartment where it is reactivated for mixing again with raw sewage. When raw sewage and activated sludge are mixed with air for 15 to 30 min. and settled, reductions in BOD from 85 to 99% are obtained; the settling characteristics are at least as good as in a satisfactorily operating conventional activated sludge plant. The aeration time required is about 90 min. The amount of excess sludge is about the same as in the conventional plant. It can be wasted from either the aerated or unaerated settled sludge. Advantages are that it requires less aeration tank capacity and only a small mixing compartment. It is easier to maintain a consistently high degree of purification. A minimum of plant and process adjustments are required for a wide range of sewage flows and loads. Primary clarification is unnecessary.

A. H. Ullrich and Mansel W. Smith—"The Biosorption Process of Sewage and Waste Treatment; *Sewage & Indus. Wastes*, October.



Courtesy Sewage & Industrial Wastes

● ***FLOW diagram of Biosorption plant.***

Removal of Screenings and Grit

Mechanically cleaned screens are preferable to hand cleaned because they require smaller structures, cause less loss of head, collect less screenings, save time of the operator, do not cause overflows by clogging. For small or medium-size plants the front-cleaned screen is preferred because it is cheaper and can be shipped completely assembled; but for large plants, the back-raked type is more dependable. Usually screenings from mechanically cleaned screens are ground and returned to the sewage. Comminutors combine screening and grinding in one unit.

It is desirable to prevent grit particles of 0.2 mm or over from entering the tanks. This is effected by regulating the velocity of flow in a sedimentation channel, from which the grit is removed by collectors, of which 6 types are described; and usually is washed by one of several devices.

S. L. Tolman—"Removal and Disposal of Screenings and Grit;" *PUBLIC WORKS*, October.

Designing Sedimentation Tanks

The major objectives of sedimentation are removal of settleable suspended solids, production of a sludge with maximum solids content, and operation without the creation of objectionable odors. In designing a tank, the factors considered are the detention period, surface area, economical depth and ratio of length to width. Tests indicate that the actual detention period is generally 1/3 to 1/2 the theoretical. Usually the theoretical detention period is about 1 hr. for preliminary treatment for activated sludge plants and following a standard rate trickling filter; 2 hr. for most sedimentation tanks, but some states require 3 hr. where only primary treatment is provided or where practically all the flow reaches the plant in 16 hr. The detention period and design flow determine the volume of the tank. The water depth should be at least 6 ft.; in most cases 8 to 10 ft. is most economical. The suggested maximum surface settling rates, in gal. per sq. ft. per day, are 600 to 900 for primary sedimentation only, or 900 to 1200 if followed by secondary treatment. For final sedimentation after trickling filters, 1,000; after high-rate filters, 900; and after activated sludge, 800. For rectangular tanks the lengths should be 3 to 5 times the width. For round tanks, 30 ft. diameter is the desirable minimum. Round tanks of greater diam-

eter than 60 ft. will usually cost less than rectangular tanks of equal volume. Several State health departments require effluent weirs of such length that the overflow will not exceed a maximum rate of 10,000 to 15,000 gpd per lin. ft., providing more than one weir if necessary. Suggestions for sludge removal, design of sludge hoppers and channels, scum drawoffs, etc. are given.

J. J. Gilbert—"Design Data and Equipment for Sedimentation;" *PUBLIC WORKS*, October.

Sludge Digestion

It is generally economical to include digestion as part of a sewage treatment process, whatever the type; the required capacity of filtration, chemical feed and incineration equipment is reduced about ¾; the amount of conditioning chemicals is reduced substantially, as is also the sludge handling equipment; storage in the digester equalizes the composition of the solids; possibility of odors is reduced, and the sludge can be disposed of without nuisance. In moderate or large-size plants the gas evolved has a considerable value. The purposes of digestion may be summarized as to produce a sludge that is inoffensive and reduced in quantity, and that may be dewatered readily; and secondarily, to produce sludge gas for use, and produce sludge that can be used as fertilizer. Sludge, with as low moisture content as possible, should be added to primary tanks as frequently as possible, and withdrawn in small increments. Best results are obtained by maintaining a temperature of 90° to 95°, uniform throughout the entire depth of the tank. The pH of the contents should be maintained between 6.8 and 7.2. Slowing down or complete cessation of digestion activity invariably accompanies or closely follows high concentration of volatile organic acids; control of this is absolutely necessary for the digestion of most industrial wastes. The formation of any considerable amount of scum should be avoided; which may be effected by the discharge of heated recirculated digester liquor at the surface of the digesting mass; aided, if necessary, by periodic addition of small amounts of solutions containing ammonia nitrogen. Foaming the author believes to be the result of violent activity due to a "layover" of solids, all of which start to digest at one time. A digestion plant should be designed with a proper arrangement of piping, valves, pumps and devices to allow the flexible operation necessary for effectively carrying out control measures. Some plants have been operated with loadings two or three times those called for by the customary standards and the author believes that, by careful control, it will be possible to effect a reduction in the capacity requirements now specified by State boards of health without sacrificing the effective destruction of organic matter, and thus reduce appreciably the cost of digestion installations.

Harry E. Schlenz—"What You Should Know About Sludge Digestion;" *PUBLIC WORKS*, October.

Activated Sludge Process

The advantages of the activated sludge process are low cost of construction, high degree of treatment, waste sludge of high fertility value, freedom from fly and odor nuisance, and ability to use the effluent for many non-potable purposes. The greater operating costs are justified by the saving in initial cost. Tentative design bases were adopted in January, 1951 by representatives of ten state health departments. These call for capacity of a diffused air aeration tank established by the following criteria: For design flows (exclusive of returned sludge) from 0.2 to 0.8 mgd the detention time shall be 7.5 hr.; in excess of 0.8 mgd detention time shall vary from 7.5 hr. at 0.8 mgd to 6 hr. at 1.0 mgd, decreasing in proportion to the increase in flow. Or, if it would give a tank of larger capacity, a tank volume of 30 cu. ft. per lb. of 5-day BOD in the aerator influent (exclusive of return sludge). For mechanical aeration, tank volumes are 50% greater. Tank depth must be 10 to 15 ft. Air supply sufficient to maintain 2 ppm dissolved oxygen in the tank, and 1,000 cfm of air per pound of applied BOD, and 150% of normal requirements. The author questions whether such rigid standards may not deter advancement in this field. He mentions, as illustrations of advancement during the past decade, "Step Aeration", "Distributed Loading" or "Multiple Point Dosing", by which good results have been obtained with as low as 2½ hr. detention. Very large benefits are obtained by only first-stage or so-called carbonaceous oxidation, which may be effected in 1½ hr. "modified aeration". An activated sludge plant can be so designed and operated as to produce any quality of effluent desired between that of plain settling and that of true activated sludge; an effluent having a BOD of 30 to 50 ppm can be obtained, with production of sludge having twice the density of ordinary activated sludge. Research during the past two years has developed the "Bisorption Process", in which screened or settled sewage is mixed with return sludge for about 20 min., utilizing air. The mixture then flows to a clarifier, where a clear effluent is produced, while the sludge is discharged into a "sludge stabilizer," where it is retained for about 2 hr. and aerated, only carbonaceous oxidation occurring. Part of the sludge from the stabilizer is returned and part wasted.

Proper operation of the activated sludge process depends on maintaining the sludge in proper condition. It is difficult for an operator to know what condition the sludge is in; one aid is to measure the dissolved oxygen in the mixed liquor at several points in the aeration tank. More helpful is the oxidation reduction potential, which indicates whether the oxidizing or the reducing processes predominate. The potential electromotive force is measured by means of a vacuum tube potentiometer equipped with an appropriate electrode system. There is a remarkable correlation between BOD of a sewage and transmission of light through it, which can be measured by use of a photoelectric cell. For a quick method of measuring suspended solids, use of a laboratory centrifuge is suggested.

A. A. Kalinske and H. W. Gillard —"Activated Sludge for Sewage and Waste Treatment;" *PUBLIC WORKS*, October.

Activated Sludge For Military Installations

The activated sludge process, with its high degree of treatment, low first cost, and freedom from odor and flies, is admirably suited for treating sewage from defense plants and military training camps. Since army camp populations fluctuate considerably, the tank capacities necessary for the maximum population should be divided into a number of tanks. The low night flows permit the plant to treat peak flows effectively without a corresponding increase in the capacity of the aeration units. In many army camps of World War II, the primary tanks removed only 20% of the BOD instead of the average 35% of municipal plants, and 25% more air per gallon

of sewage was required. For such conditions, preaeration for 30 to 45 min. is recommended. At Ft. McClellan, preaeration increased BOD removal from 30% to 66.3%.

Miles Lamb — "Designing Activated Sludge Treatment Plants;" *PUBLIC WORKS*, October.

Designing Trickling Filters

The trickling filter has proved to be one of the most versatile tools in biologic treatment of sewage and organic industrial wastes. Since the war the use of high-rate filters has been increasing and more plants using them have been installed in this country and Canada than all other types of biologic treatment plants combined. In January, 1951 public health engineers representing ten states adopted tentative standards for filters differing from those previously in use chiefly in the method of determining performance, abandoning the loading per unit of area in favor of loading per unit of volume. For single-stage units, maximum loading, including recirculation, should not exceed 110 lb., per 1,000 cu. ft. of filter, or 4,800 lb. per AF. (Filter depths are not mentioned.) Dosing rate should be in excess of 10 mgad and up to 30 mgad, recirculation included.

By inserting high-rate filters between existing primary clarifiers and filters in an overloaded standard filter plant, many such plants have been rejuvenated at considerably less cost than that of a new plant.

R. S. Rankin—"How to Design Trickling Filters;" *PUBLIC WORKS*, October.

Pumps for Sewage Plants

Selecting a pump and designing a wet wall for a new sewage pumping station are to be based upon the present 24-hr. average rate of flow; the 24-hr. design flow of the station; and the peak rate of flow. The wet well should be as small as possible to prevent the sewage becoming septic, yet large enough to satisfy operating and space requirements of the pumps. Duplicate pumps rated at 175% of design flow are recommended for flows up to 0.2 mgd. Three pumps of 50-70%, 100% and 220%, respectively, of average 24-hr. flow for flows of 0.2 to 4.0 mgd. And four or more pumps for larger stations. Closed shaft pumps are not recommended for use in wet wells. Centrifugal pumps should not be used for handling sludge if there is much gas or air in it, nor with a suction lift without a priming chamber. They often clog when pumping primary sludge. Plunger pumps will handle sludge and are self-priming; but they are noisy, require considerable maintenance to keep the packing tight and the valves free of stringy material. For any type of pump, a positive head on the suction is desirable. The suction line should be as short as possible, its junction with the pump never lower than any other point in the line, contain the fewest possible number of bends; and no foot valves, check valves or sludge shoes should be used on the suction side of the pump.

James B. Neighbor — "Selecting and Installing Pumps for Sewage and Sludge;" *PUBLIC WORKS*. October.

Reducing Wear in Mechanical Equipment

The Gary, Ind., Sanitary District has adopted several practices which reduce wear in its mechanical equipment. Impellers in the raw sewage pumps formerly lasted only about three years because of grit in the

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sewage, and replacement of impellers, guide and wearing rings cost approximately $4,000. In addition, there was progressive lowering of pump efficiencies. All sewage pumps now are provided with rubber covering, which lasts about a year and costs $130 to replace. Pump efficiency is increased, reducing gas consumption at a saving of $144 a month. Wear on plungers in the direct-acting simplex pumps used for raw sludge was excessive on account of fine grit in the sludge; chrome plating of new plungers, and of old ones machined, so decreases the wear as to save $35 per plunger. Piston pins on gas engines wear elliptical, but instead of replacing them, the old ones are machined round and chrome plated to their original diameter, with a saving of just over $30 per pin.

W. W. Mathews—"How Some Operation Problems Were Solved At Gary Plant;" *Wastes Engineering*, October.

Waste Treatment By General Electric Co.

The General Electric Co. has inaugurated a country-wide program of industrial waste control and treatment. Each individual existing plant with a pollution problem is held responsible for its solution. In planning new plants and extensions, waste control and treatment facilities are included. Where a pollution problem already exists, the first effort is to take all economical steps short of treatment to reduce the pollution load—care, good housekeeping, recovery, segregation, conservation, process change, and repiping. Recirculation and reuse of all water of proper quality for which it is economical to take such action is encouraged; also the establishing of minimum quantities of water necessary to do each particular job and insisting that the plant operate on this minimum plus a reasonable safety factor. The company recently placed in operation at Erie, Pa. a plant for treating metal wastes that cost approximately $1,000,000.

Kenneth S. Watson — "Waste Treatment Developments in the General Electric Co.;" *Sewage and Industrial Wastes*, September.

Five-Day Sludge Concentration

A plant to handle 150 mgd of sewage from communities in Allegheny County, Pa., is now being designed by Metcalf & Eddy for the Allegheny County Sanitary Authority. This will embody ideas developed by a year's study with a laboratory and a pilot plant under the direction of John F. Laboon, chairman of the Authority. The fundamental idea is that of limiting the period of concentration of sludge to 5 days, instead of the customary 30 days or more, thus reducing greatly the size or number of tanks required. Preheated sludge was kept at 95° temperature for five days, when a large percentage of solids was floating at the surface, with a 16% to 24% solids content. If left longer, it settled to the bottom and became more dilute. While the solids were still floating, the comparative clear liquid below them was drawn off until the solids rested on the bottom. This sludge had the consistency of damp cohesive soil with fibers added. Conventional pumps would not handle it, but it was found that the Moyno progressing cavity pump would. With this pump working at 64 psi, the sludge is homogenized and flows through a pipe line as a soupy fluid without tendency to settle or cake on the pipe walls. It was found that it could be filtered on a vacuum filter

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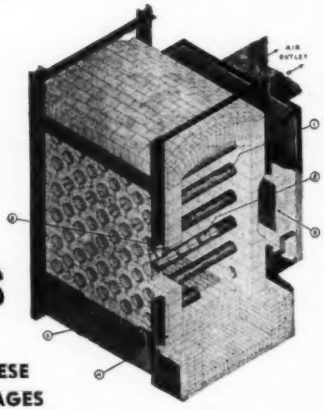

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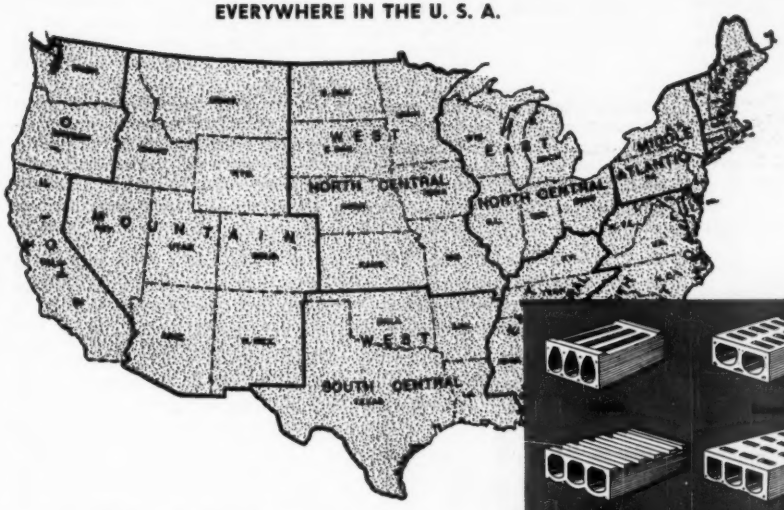

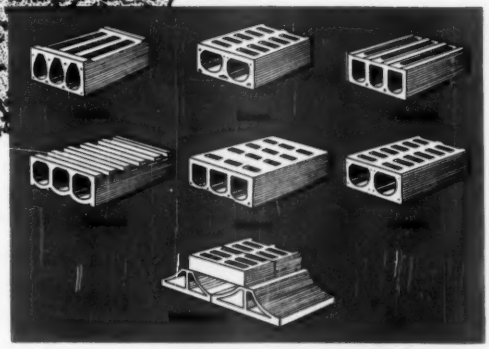

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without any chemical conditioning, forming a cake of 32% solids ¼ in. thick. Studies are now being conducted to learn whether this thick sludge can be digested in a tank provided with agitating mechanism to facilitate the escape of gases; if so, digestion tanks can be made much smaller. However, the Allegheny County plant will burn the sludge, mixed with what fuel is found necessary—coal will be used, in multiple-hearth incinerators.

"Concentrated Sludge: The Laboon Process;" *Engineering News-Record*, Oct. 11.

Effect of Cyanide on Biochemical Oxidation

Studies by the U.S.P.H.S. led to conclusions that: 1—The effect of cyanide on the inhibition of BOD is quite variable, depending on the type of water, specialized seed developed, and other factors. 2—Specialized microbic growths are able to affect self-purification and oxidize organic matter in the presence of cyanide after an initial lag period of a duration depending on cyanide content and the stage of development of the seed organisms. 3—Little loss of cyanides accomplished during the 5-day period, except in water samples in which there is a previous history of cyanide pollution and in which a suitable flora is already developed. 4—The loss of cyanide from volatilization during stream self-purification is more rapid than that produced by chemical or biochemical destruction, except when specialized flora has previously been developed in the water. 5—There was a proportionately greater effect of small doses of cyanide on the inhibition of BOD. Higher cyanide concentrations showed relative small additional increments of inhibitions so long as the cyanide content was not appreciably greater than 6 ppm. 6—In all of the waters studied, cyanide concentrations up to 6 ppm were purified as much as 50% or more of the control within the 10 days of incubation.

F. J. Ludzack, W. A. Moore, H. L. Krieger and C. C. Ruchhoft—"Effect of Cyanide on Biochemical Oxidation in Sewage and Polluted Water;" *Sewage and Industrial Wastes*, October.

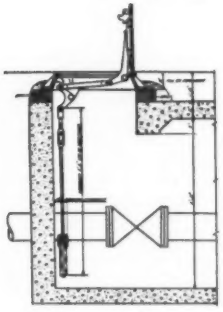
Pollution by Oil Well Drilling Chemicals

With the recent increase of oil wells in Texas bays, the possibility of pollution from chemical compounds used in drilling which would be injurious to marine organisms led to tests by the Marine Laboratory. Eight of the compounds failed to kill test animals in concentration as high as 7,500 ppm. Five—sodium acid pyrophosphate, quadrafos, impermex, sodium polyphosphate and stabilite No. 9 were toxic in concentrations of 500 to 7,500 ppm. Caustic soda, oil well cement, tannex and white lime were found to be usually lethal in concentrations of 70 to 450 ppm, more toxic to fish than to oysters. Twelve different species of marine animals were used in the tests. There appeared to be little danger from these compounds when released in open bay waters.

F. M. Daugherty, Jr.—"Effects of Some Chemicals Used in Oil Well Drilling on Marine Animals;" *Sewage and Industrial Wastes*, October.

Disposal of Citrus By-products Wastes

A California citrus fruit processing plant processing an average of approximately 15,000 tons of fruit a month produces a daily flow of liquid wastes of about 0.70 mgd, made up of cooling water, pectin wastes, pulp press liquor, processing plant wastes, and cannery floor



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washings, which contain 6 tons of BOD. Disposal of this has been accomplished economically and satisfactorily by spreading the untreated wastes onto porous sandy soils. Spreading basins rather than furrows are employed, in order to obtain good distribution together with positive protection against overflows. Spreading within the basins is best accomplished by the use of "back-furrows," which retards the velocity of flow and thus increases the rate of infiltration. By using ample ground area, a uniform, positive and safe operation is assured. The wastes infiltrate into the ground readily. The suspended solids screened out at the surface form a layer thin enough to dry promptly, so that insect and odor nuisances are practically eliminated. Any organic materials reaching the underground waters appear to be completely stabilized and greatly diluted. By using the soil alternately for spreading and cropping, much of the organic content of the wastes is reclaimed as fertilizer.

Harvey F. Ludwig and Gordon W. Ludwig—"Disposal of Citrus By-products Wastes at Ontario, Calif.;" *Sewage and Industrial Wastes*, October.

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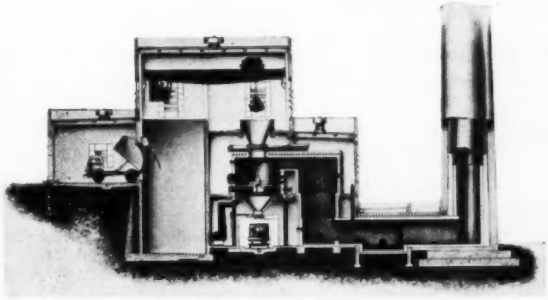

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Winston-Salem Water

(*Continued from page* 46)

mined minimum of weight of chlorine on the scale. Cylinders are handled by an electric lift, on a monorail. Platform storage for 30 cylinders is provided. To measure the chlorine residual in the plant effluent, a Wallace & Tiernan amperometric chlorine residual recorder is installed. A recording pH meter, Bristol Pyromaster, with Beckman Model R amplifiers, is provided with the recorder in the corridor between the old and new filters.

The rate of flow through the venturi meter is indicated and recorded by a Simplex Type H recorder located in the corridor and also at a recorder in the operator's room in the chemical feed building. This same transmitted rate automatically controls the feeding rate of the coagulant and lime feeders, proportioning the feed according to the flow rates. There are three gravimetric, loss-of-weight type, Omega feeders, with capacity ranges of 5 to 500 pounds per hour, based on material weighing 70 lbs. per cubic ft. All of the feeders are set over solution tanks, 30 ins. square and 21 ins. liquid depth, with high speed mixers and water ejectors. The 2-inch solution lines are rubber lined. Dissolving tanks and eductors are of stainless steel.

A manually controlled ammoniator is provided and one of the lime feeders originally installed as a secondary feeder has been converted to a fluoridator, suitable for feeding sodium silicofluoride. The point of application will be in the chlorine contact chamber. The fluoridation and lime feeder hoppers extend to the floor above where dust collectors are provided. A Calgon dissolving tank also is located in this room. Storage is provided for the three chemicals. A 2-ton Yale & Towne hoist, on a monorail, is provided for handling the chemicals.

Filtered water storage at the plant consists of three basins, two of which were a part of the original plant. These two basins are of concrete, open, 175 ft. in diameter and with maximum depths of 13 to 10 ft., respectively, giving total storage of about 4.1 mg. The piping on these basins has been modified so that the water enters on the side opposite the outlet, providing circulation across the basins. The new basin is 185 ft. in diameter, with a capacity of 2.0 mg. Subsoil conditions under this

basin necessitated piling to a depth of 25 ft. under its entire perimeter, and strengthening of the footings. The top rim is so constructed that a cover may be added, if desired.

The Pumping Station

In the original high pressure pumping station, there were four electrically driven pumps, two of 4.0 mgd and two of 2.5 mgd; also five 2-mgd gasoline engine driven units, normally used for standby; and a 6-mgd pump which was installed in 1948. All of the existing pumps were retained and three new ones were installed. These are Morris, double suction, horizontal split case, two-stage, with a capacity of 6 mgd each. They are driven by 450 hp GE synchronous, horizontal sleeve bearing type motors, operating on 2,300 volt, 3-phase, 60-cycle current.

Additional heating capacity had to be provided for the plant, and the piping was also insufficient to convey steam from the old boiler location to the new filters. Therefore, a new heating plant was installed in a new and more efficient location. Unit heaters are provided, except in the laboratory, offices and chlorinator and lime feed rooms, where radiators are used. Fluorescent lighting is provided in the offices, laboratory, operating gallery and new filter areas. Outside basins are lighted by batteries of three 500-watt floodlights on standards.

Architecture of the new buildings was blended closely with the old to form an attractive appearance. Brick were obtained which closely matched the existing brick and these were laid with the same joint spacing and arrangement. Stone trim was also closely matched. Laboratory furniture is Kewanee built-in cabinet type. Throughout the laboratory and office sections, flooring is of rubber tile; in the filter gallery and connecting corridor it is red quarry tile. Stair treads are of Feralum.

Distribution system improvements have been made and more are planned. A new 24-inch main extends from the pumping station to the east side of the city, and on in to the center of the city, intersecting and reinforcing other principal lines on its way. On the far side of the city, a new 1 mg elevated tank will be constructed in order better to balance pressures and care for water demands. Other feeder lines will be provided in order to insure adequate pressures throughout the distribution system.

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The Winston-Salem city officials during the construction period were C. E. Perkins, City Manager; H. A. Thomas, Director of Public Works; and Stanley Harris, Superintendent of Water and Sewage. V. B. Higgins of Greensboro was the contractor on the filter plant and his superintendent was R. J. Patterson. The pipe was furnished by Lock Joint Pipe Company and the Bethlehem Steel Company, and installed by Blythe Bros. The consulting engineers were John L. Spinks of Winston-Salem and Albright & Friel, Inc. of Philadelphia.

• • •

Curbs and Gutters

(*Continued from page 43*)

the use of all face forms was eliminated; (3) concrete laid by hand in very hot weather is a back-breaking job and by forming the concrete for the curb and gutter by machine, the necessity for additional concrete finishers was eliminated; and (4) during light rains the machine can be operated if the concrete is immediately covered for its protection.

We have found that the curb and gutter machine can be used successfully to construct straight curb. It will construct moderately long curves; however, it cannot be used on street radii or similar small curves. The curb can easily be dropped for driveways, but some delays are encountered when pouring around catchbasin inlets. It is better to follow the machine with a small crew detailed to construct curb around catchbasins and at curves at intersections.

• • •

Wisconsin Bill Permits Escalator Clause

JOHN HUBEL

In July, Governor Walter Kohler of Wisconsin signed a bill which became Chapter 559 of Wisconsin Laws of 1951, amending Section 62.15 of the Statutes. The new law provides that on any public works contract whose cost exceeds $1,000, formal bids shall be taken and the contract awarded to the lowest responsible bidder. Previously, the amount of public construction that could be done without formal bids was $500.

In discussing this new law, J. V. Duffy, president of the Wisconsin Chapter of the National Institute of Governmental Purchasing, Inc., and city purchasing agent for Kenosha, Wisconsin, said that, in his opinion,

"our legislators have apparently recognized that the dollar has dropped to about half its former value and have increased the amount accordingly. I believe this has been very helpful to all public buyers.

"This act also provides", Duffy continued, "for the use of escalator clauses, in public works contracts, not to exceed 15% of the amount of the bid. While none of us like escalator clauses and would prefer to operate without them, it appears that an escalator clause is almost a necessity, particularly on large construction projects which may take months, or even years, to complete. It would seem that the contractor needs some protection against increases in labor and materials over which he has no control.

"We took bids recently", Duffy added, "for the construction of a $180,000 addition to our incinerator, and we included reference to this in our specifications. On the first call for bids we received bids for the furnace and chimney but none for the construction of the building. We re-advertised for bids for the building only and received a bid from a local contractor. However, the successful contractors for the building and for the furnaces bid firm prices and did not take advantage of the escalator clause. It seems a little difficult, therefore, to form an opinion as to just what the effect of this new law will be on public construction jobs. It is known that some contractors are hesitant to bid without an escalator clause, but here we have the first case in which we have allowed an escalator up to 15% and the contractor bid firm prices."

The city of Kenosha, Duffy advises, is contemplating the construction of a half-million dollar addition to the water filtration plant, for which the city is awaiting approval of the application in Washington. If and when the federal authorities approve the project, it will be interesting to find out how many of the contractors bidding will include the escalator clause in their bids, according to Duffy.

• • •

The Eschenbrenner Awards

The second annual Eschenbrenner Awards have been announced by the Universal Concrete Pipe Co., Columbus, O. Three $500 awards will be given. Entries are restricted to senior civil engineering students in colleges and universities east of the Mississippi. Subject matter must relate to non-monolithic concrete.

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Public Works EQUIPMENT NEWS

Nelson loader for salt, etc.

Fast Loader for Salt, Sand or Snow

The illustration shows one of twenty special machines designed and built by Nelson for the City of New York. These machines will load into trucks or bins 6 cubic yards of salt or sand per minute, and 10 cubic yards of snow per minute, or more under favorable conditions. More data from N. P. Nelson Iron Works, Clifton, N. J., or by using the coupon.

Use coupon on page 101; circle No. 12-1

Composter for Garbage and Sludge Disposal

By using a silo-type composter, to which is added a bacterial culture, a rapid process of decomposition is promoted which quickly reduces garbage and sludge to a high-quality compost which can be sold for soil conditioner. Capacities range from 10 to 100 tons. Full data from American Composter Co., 4016 South Cedar St., Lansing 10, Mich., or by using the coupon.

Use coupon on page 101; circle No. 12-2

Plug Your Ears When This Siren Sounds

The loudest sustained noisemaker ever designed by man for modern production is said to be this new 2½-ton siren. Under normal weather conditions it can be heard for 7½ miles. Its 140-hp engine powers both a blower, emitting winds up to 375 mph into six sound horns, and a high speed six-bladed rotary chopper that interrupts the flow of air to create the noise. The warning sound is rated at 170 decibels. Making one complete revolution per minute, the siren is audible to an area 15 miles in diameter. Write Chrysler Corp., Detroit, Mich., or use the coupon.

Use coupon on page 101; circle No. 12-3

King-sized siren.

Preserves and Makes Masonry Surfaces Water Repellent

Invisible silicone is a non-staining water repellent coating for porous exterior masonry surfaces, such as brick, concrete, stucco or mortar. It is applied by brush or spray and does not change the color or texture of the surface it is applied to, but penetrates to one-fourth-inch. Ask for data on Silipruf from Preco Chemical Corp., 40 E. 40 St., New York, or use the coupon.

Use coupon on page 101; circle No. 12-4

Chemical Slows Grass Growth and Reduces Mowing Need

Maleic hydrazide has been shown to slow the growth of grass so that marked savings may be realized in less frequent roadside and parkway mowings. Also, mixed with 2,4-D, weeds are killed at the same time. Application costs about $10 per acre and experiments indicate seasonal saving per acre at about $70. Full data from U. S. Rubber Co., Rockefeller Center, N. Y., or use the coupon.

Use coupon on page 101; circle No. 12-5

Tenite Plastic Markers for Street Lining

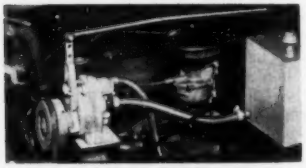
The new Duro-Line tenite plastic markers are made in the form of a 4½-inch disc, saucer-shaped, and are usually spaced about 2 ft. apart. Breakage is negligible and average life is 4 to 6 years. Two average workers can lay these markers at the rate of 100 per hour and traffic can pass over them as soon as they are down. They are solid color all the way through and wear does not dull their visibility. Complete information from Traffic Safety Supply Co., NE Sandy Blvd., at 27th, Portland 12, Ore., or use the coupon.

Use coupon on page 101; circle No. 12-6

Dur-o-line markers keep bright.

Hydraulic Lift for Better Snow Plow Operation

Easily installed on truck-mounted snow plows, this newly developed hydraulic lift is actuated by a hydraulic pump operated by the engine fan belt. Further, the pump is equipped with a clutch so that the pump runs only when power is needed, adding to the life of the equipment. Use of this lift permits the plow blade to be raised quickly to prevent grinding on bare pavements and to avoid obstructions. Operation is by push-button on the dash, permitting one-man operation if desired. Information in detail from National Lift Co., Waukesha, Wisc., or use the coupon.



Lift for snow plows

Use coupon on page 101; circle No. 12-7

Diesel Power for Road Building Equipment

Seven asphalt paving rollers, manufactured by Buffalo-Springfield, and operated by George M. Brewster & Son, Inc., contractors of Bogota, N. J., have recently been equipped with Detroit diesel engines. The rollers, which weigh 20 tons each ballasted, are powered with 3-cylinder engines. The chief advantage is reported to be a smoothness in power flow, with consequent substantial reduction in rolling time required. More data from Detroit Diesel Engine Div., Detroit 28, Mich., or use the coupon.

Use coupon on page 101; circle No. 12-8

Roller with diesel engine.

Mowing in close corners.

Portable Scythe for Trimming in Difficult Places

Weighing only 25 pounds, this power operated portable scythe or mower is designed for cutting grass, weeds or light brush, in places that are normally inaccessible to power mowers, even under water. It cuts a 20-inch swath and runs six hours on a gallon of gasoline. Cuts any place a man can walk or row a boat. More from Hoffco, Inc., Richmond, Ind., or use the coupon.

Use coupon on page 101; circle No. 12-9

Fiberglas Used to Line Canals and Ditches

Irrigation canal liner is a new product to control seepage and erosion in ditches and canals, but it may also be used in swimming pools and ponds. It is a fiberglas-reinforced prefabricated asphaltic membrane lining which can be installed with hand tools and unskilled labor. A crew of 4 to 6 men can normally apply 200 to 300 sq. yds. per hour. An excellent folder is available which gives many details of application and use. This can be obtained from Owens-Corning Fiberglas Corp., Toledo 1, Ohio, or by using the coupon.

Use coupon on page 101; circle No. 12-10

Fiberglas canal liner.

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Designed especially for sidewalks, streets, school and hospital grounds, parks, skating rinks and parking lots, this light rotary plow will move a ton of snow a minute from a 33-inch wide path. It will throw snow to 65 ft. in any direction the operator selects. It weighs 990 pounds and has a 10 hp motor. More data from Toro Mfg. Corp., Minneapolis, Minn., or use the coupon.

Use coupon on page 101; circle No. 12-11

Back-Rippers Available for Angling Bulldozers

Rippers which dig and rip when the tractor backs up are now available for angling blade bulldozers. These teeth float on the ground when the tractor moves forward; dig on the backward motion; and can be locked up out of the way when not needed. Complete data on these back-rippers from Preco, Inc., 6300 East Slauson Ave., Los Angeles 22, Calif., or by using the coupon.

Use coupon on page 101; circle No. 12-12

Permanent Traffic Line Becomes Part of Road

The "Perma-Line", said to be a truly permanent traffic line, is a plasticized product which is laid by a special machine. A hot or cold filler, 2 to 6 inches wide and half an inch deep, is placed which becomes an integral part of the road. By changing the ratio of filler chemicals, the expansion and contraction coefficient can be made identical with whatever road surface is used. These lines remain white, wear at the same rate as the road and are not slippery. Full data from Perma-Line Corp., 10 W. 47th St., N. Y., or use the coupon.

Use coupon on page 101; circle No. 12-13

Better traffic markings

Chemical Weed Killer Produces Bare Soil

A non-selective weed killer "erases" dense growths of mixed grasses and broad-leaved weeds, leaving only bare soil. Known as CMU, this is a Du Pont product and is not flammable or corrosive. It is applied as a spray, using a wettable powder in water. Effects begin in 3 to 10 days. Duration of sterility is being investigated. More data from Du Pont, Wilmington, Del.

Use coupon on page 101; circle No. 12-14

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30 "FLEXIBLE" power bucket machines have been working in the Kansas City flood area since August! This is no doubt America's *all-time-biggest* sewer cleaning job. To aid the stricken area quickly, many cities from as far away as Ohio, Minnesota and Texas made their "FLEXIBLE" equipment available under "FLEXIBLE" supervision, in addition to those immediately supplied by the factory.

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Enough for a week,
I wonder just how
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- **Portability** - constructed of sturdy cast aluminum with carrying handle for easy portability. One man can easily handle the Pelican.
- **Non-Clogging** - any muck or solids that will pass the intake strainer will pass through the pump.
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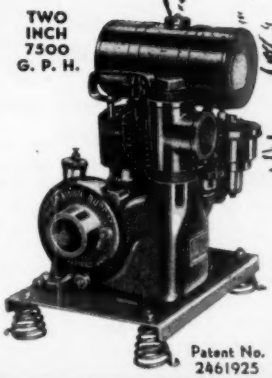

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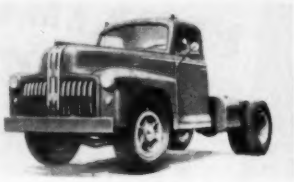
Three Models in New Federal Motor Truck Line

A new series of Federal motor trucks has been announced, comprising three models—3401, 3402 and 3404. Gross vehicle weights are 23,000 to 25,000 pounds, with tractor-trailer ratings to 45,000 pounds. Wheelbase lengths are from 136 to 250 ins. Chassis and cab weight of the shortest wheelbase units start at 7,210 pounds. Engines are 6-cylinder, valve-in-head, with 371 cu. ins. displacement and 145 hp at 3000 rpm. There are many additional features of these new trucks. For full data write Federal Motor Truck Co., Detroit, Mich., or use coupon.

Use coupon on page 101; circle No. 12-15



New Federal truck

Powerful Coaster Siren for Emergency Vehicles

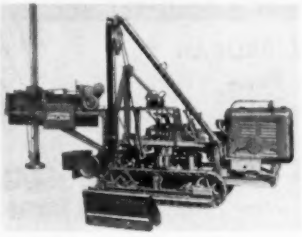
Designated as the "Q" class, this new siren is said to have the most powerful tone of any siren on the market for this type of application. It is powered by a new motor which produces more sound with less current. Two models are available—one for outside mounting; the other for under-the-hood mounting. An electric brake can be supplied and a standard mounting is furnished. More data from Federal Enterprises, Inc., Signal Division, Chicago 19, Ill., or by using the coupon on page 101 of this issue.

Use coupon on page 101; circle No. 12-16

Powerful siren

One-Man- Backfiller, Tamper and Pipe-Layer

This machine will reduce labor costs on any trenching or pipe-laying work. It can be used for handling and laying pipe, for light crane work and for backfilling and tamping. It is crawler-mounted. The tamper delivers a 380-lb. blow 45 times a minute and permits relaying of pavement at once. It backfills from either the spoil-bank or the opposite side of the trench. More data from Cleveland Trencher Co., Cleveland 17, O., or use the coupon.



Backfiller-tamper-pipelayer

Use coupon on page 101; circle No. 12-17

Portable Steel Bleacher For Seating Crowds

This portable steel-bleacher can be towed, carried or demounted into small units for moving. Sections are 12 ft. long, 5 rows high and weigh 789 pounds with planks, or 325 pounds without planks. Seating capacity is 8 per row or 40 per section. Sections are furnished 5, 10, 15 or any multiple of 5 rows high, with guard rails as required. Cleats are included and planking, if desired. Get literature and specifications from Seating, Inc., 3565 Wooddale Ave., Minneapolis 16, Minn., or by using the coupon.

Use coupon on page 101; circle No. 12-18

A Steel Rule that "Sees" in the Dark

A locking lever indicates the exact measurement taken with this steel rule. In the dark, extend the tape to make the necessary measurement, then flick the locking lever and move into the light. The measurement is read at the top of the case without computation. This "Streamline" rule can be used for inside or outside measure, height or depth gage, outside caliper or

layout work. Information from Master Rule Mfg. Co., Middletown, N. Y., or by using the coupon.

Use coupon on page 101; circle No. 12-19

Atomic Battery Generates Current from Radioactivity

An atomic battery in which electrical current is generated from radioactivity has been announced. Although very small motors have been run, practical applications for the present will be limited to control instruments, including a small monitor to detect radioactive contamination of water and a new level gauge. Data from Ohmart Corp., Cincinnati, O., or use the coupon.

PERSONAL NEWS

Joseph A. LePrince has been presented by the National Malaria Society with the first Joseph Augustin LePrince Award, which was established in his honor. Mr. LePrince, with Dr. Gorgas, eliminated yellow fever and malaria from the Canal Zone. Later, in World War I, he supervised the work of malaria control in extra-military areas; and he advised on many problems in World War II. An outstanding engineer and a great man, Mr. LePrince is entitled to all of the many honors that have been awarded him.

Fred Burggraf has been named director of the Highway Research Board, succeeding the late Roy Crum. Mr. Burggraf has been associated with the Board for the past eleven years, and previously from 1928 to 1932; and he has been connected with highway research problems since 1919. His selection as director is a happy choice.

Col. Harry E. Fisher is now vice-president of the Airways Engineering Corp., Washington, D. C. A graduate of West Point, Col. Fisher has had 31 years of military service, much of it with the Air Force.

ASSOCIATIONS

South Dakota Water & Sewage Works Conference

An interesting news story of the 17th annual meeting of this conference has been sent us by Charles E. Carl, Director of the Division of Sanitary Engineering, along with some photographs of men and events at the meeting. The conference was held on Sept. 19 to 21, at Yankton, S. D., which has just completed a new 4 mgd water treatment plant.

Street and Highway Problems Conference

The Fourth California Conference on Street and Highway Problems will be held at the University of California, Los Angeles, February 6 to 8, 1952.

Centennial of Engineering

Frank W. Edwards, director of the department of civil engineering at Illinois Institute of Technology, has been appointed general manager of the Centennial of Engineering, planned for Chicago during the summer of 1952.

LANDSLIDE BIBLIOGRAPHY

Issued by the Highway Research Board,, Washington 25, D. C., this bibliography lists 291 articles on landslide data, with brief comment on each. No price is given.

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Data on Rotary Distributors For Sewage Treatment

118. Data on Infilco rotary distributors which feature low head requirements, uniform distribution, streamline design, double seal against sewage loss, and corrosion resistant construction, will be found in Bulletin 6400. For your copy, use the handy coupon or write Infilco Inc., Box 5033, Tucson, Ariz.

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123. In the Leschen Wire Rope Handbook you will find interesting descriptions of every type of wire rope, weights and breaking strengths of all classifications, suggested rope types for various jobs, and a wealth of other information. Check the coupon for 64-page booklet R-51. A. Leschen & Sons Rope Co., 5909 Kennerly Ave., St. Louis 12, Mo.

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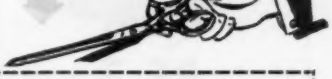

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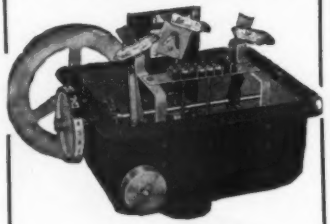

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20 Questions and Answers On Sanitary Landfill

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164. A new presentation, written especially for municipal officials, offers a modern solution for the garbage disposal problem. Be sure you have this up-to-date information on the elimination of city garbage collection by the use of Hotpoint Disposall units. Check the coupon now. Hotpoint Disposall Department, 5600 West Taylor St., Chicago 44, Ill.

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177. Strategically spotted bulk containers can be handled by one man operating a Dempster-Dumpster equipped truck. Get full details of this cost-saving system of rubbish collection, as used by many cities to increase efficiency and eliminate unsanitary conditions. Write Dempster Brothers, Inc., 1291 Dempster Bldg., Knoxville 17, Tenn., or use the handy coupon.

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215. Recuperators featuring individual replacement of the heat transfer elements (silicon carbide tubes) for maximum accessibility and efficiency are described and illustrated in Bulletin 14 issued by Fitch Recuperator Co., Dept. PW, Plainfield Nat'l Bank Bldg., Plainfield, N. J.

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68. International Harvester Company has available a new folder describing its line of diesel engines and power units for all your power needs up to 180 hp. For a copy of this colorful booklet, write to International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., and ask for Form A-156-NN, or use the handy coupon and we will forward your request.

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169. Data on stationary, portable, and standby electric plants, AC and DC, are offered by D. W. Onan & Sons, Inc., 7657 University Ave., Minneapolis 5, Minn. Several bulletins cover diesel and gasoline-driven plants for every purpose. Just check the coupon for your copies.

Are You Ready Now To Make Main Repairs?

214. Broken water mains can quickly be repaired when you have "Skinner-Seal" Split Coupling Clamps on hand. Get Skinner Catalog 41 now—this handsome 40-page book shows how to make every type of pipe repair and covers a complete line of clamps to do the job quickly and easily. Just check the handy coupon for your copy. M. B. Skinner & Co., So. Bend 21, Ind.

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33. 100% metering as practiced by many cities requires accurate, dependable meters with interchangeable parts. Cut-away views of every part, capacity and size data are all included in handsome American-Niagara water meter booklet available from Buffalo Meter Co., 2920 Main St., Buffalo 14, N. Y.

Helpful Valve and Fittings Catalog for Engineers

42. A complete 44-page catalog covering the M and H line of water works and sewage disposal equipment and accessories is offered to help design engineers and contractors who specify valves, hydrants and fittings. Get Catalog 34 from M & H Valve & Fitting Co., Anniston, Ala. by using the handy coupon.

Cement Lining for Smaller Diameter Water Lines

89. Water lines from 4" to 12" diameter are now cement-lined in place by Centriline Corp., using the Tate process. Catalog C-50

tells how this operation gives new pipe performance to old lines, and shows just how the work is done. An interesting folder, well worth studying. Check coupon for your copy. Centriline Corp., 140 Cedar St., New York 6, N. Y.

The Turbidimeter Without Standards

51. The Hellige Turbidimeter is designed for accurate measurement of water turbidity, sulfate determinations, and measurements of suspended solids and colloids in general. No standards must be prepared for use with this instrument. Detailed description of working principle and the instrument itself covered in Catalog 8000-A available from Hellige, Inc., Dept. PW, 3718 Northern Blvd., Long Island City 1, N. Y., or by checking handy coupon.

All Electric Floatless Liquid Level Control

78. Description of operating principles and applications of B/W controls shows the simplicity and many uses of these all-electric, floatless devices. Diagrams of typical installations and engineering data all in bulletin 147 issued by B/W Controller Corp., Dept. PW. 2224 E. Maple Rd., Birmingham, Mich.

Factors to Consider in Elevated Tank Selection

80. An interesting discussion of the factors to be considered for selection of elevated capacities and sizes, required fire flows and other useful data are included in a bulletin on elevated water storage published by Pittsburgh-Des Moines Steel Co., Neville Island P. O., Pittsburgh 25, Pa.

Specs for Gate Valves

112. Rigidly inspected gate valves for pressures up to 175 lbs. by R. D. Wood Co. Sizes 2" to 30"; for any standard type joint. R. D. Wood Co., Public Ledger Bldg., Philadelphia 5, Pa.

Painting Water Tanks For Longer Protection

94. High labor costs demand special consideration when painting elevated water tanks. This and other factors involved in proper paint selection are discussed in a bulletin issued by Jos. Dixon Crucible Co., Dept. 12P, Jersey City 3, N. J. Helpful specifications for repainting water tanks are also included.

Rapid Sand and Pressure Filter Data

109. Rapid sand filters. A complete line of vertical and horizontal pressure filters, wooden gravity filters, and filter tables and other equipment. For engineering data, write Roberts Filter Manufacturing Co., 640 Columbia Ave., Darby, Pa.

Rehabilitation for Your Water System

153. Whether your water supply system requires a complete rehabilitation program including an engineering survey, hydraulic analysis, reconditioning and related construction, or merely pipe cleaning and coating, it is wise to plan your campaign without delay. Get full data now on the requirements to put your system in top condition. Write Pittsburgh Pipe Cleaner Co., 133 Dahlem St., Pittsburgh 6, Pa., or check handy coupon.

What You Should Know About Fluoridation and Fluoridators

155. Two helpful publications issued by Wallace & Tiernan titled "Fluoridation" and "Fluoridators" show the development of fluoridation, list the chemicals and dosage normally used, and give full technical data on solution feed and dry feed fluoridators. Be sure to get these publications from Wallace & Tiernan by checking the coupon today.

Helpful Book Gives Pipe Flow

159. This handy 40-page pocket size book titled "Measurement of Water Flow Through Pipe Orifice with Free Discharge" explains the Layne pipe orifice meter method of computing water flow. Includes flow graphs for various size pipes. Layne & Bowler, Inc., Box 215, Hollywood Station, Memphis 8, Tenn.

Pipe Joint Essentials and Couplings for Every Job

168. Superior pipe joints are tight, flexible, simple, strong and economical. Dresser's handsome 34-page bulletin No. 513 shows how these essentials are met and provides layouts for curves, working pressures and a wealth of other data. Be sure to check this bulletin on the coupon. Dresser Mfg. Div., 59 Fisher Ave., Bradford, Pa.

How to Design Chemical Feed Systems

179. In a 12-page booklet published by Proportioneers, the many factors which enter into the design of a chemical feed system are discussed, and the types of systems used described in detail. These include dry feed, both volumetric and gravimetric and solution feed of the decanter and positive displacement pump types. Feeder controls are considered in detail. Send now for File No. RP-9080 by checking coupon. Proportioneers, Inc., Providence 1, R. I.

Engineering Data On Mechanical Joint C.I. Pipe

183. General specification, weights and dimensions of mechanical joint cast iron pipe and fittings are furnished in a 32-page booklet issued by Alabama Pipe Co., Anniston, Ala. Get this helpful data by checking coupon.

Installation Guide for Transite Pressure Pipe

192. A conveninent, pocket-size book of 115 pages covers the whole job from receiving and handling pipe to pressure and leakage tests of finished lines. Over 100 drawings show important operations, and the text tells both how and why. Copies are available from Johns-Manville, Dept. PW, 22 E. 40th St., New York 16, N. Y.

Investigate This Compact Flow Meter for Water

226. The Foster "Flow Tube" is a new metering element that is compact and easy to install. Bulletin FT illustrates simple element containing nozzles for differential pressure production and shows capacity range and accuracy. Made in standard type sizes. Foster Engineering Co., Union, N. J. will send copy or use coupon.

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Excellent Booklet Shows Aerial Mapping Technique

27. A clear explanation of the technique of aerial topographic map production is given in "Air Speeds Your Map Needs." Striking photographs trace aerial photos step-by-step to the final maps for highway location, city and regional zoning and planning, traffic studies, drainage and watershed projects, tax maps and many other types of work. Use the coupon to get this excellent booket for public works and planning officials. Jack Ammann. Photogrammetric Engineers, 829 N. St. Mary's St., San Antonio 2, Texas.

Combination Overhead And Front-End Shovel

194. The "Lodover", described in Bulletin LO 200, is a combination overhead and front-end shovel for International T-9 and TD-9

LODOVER

tractors. By digging in front, swinging load overhead and dumping to the rear, extra yards are handled every hour. Regular front-end loading is not impeded in any way. Service Supply Corporation, 2004 Erie Ave., Philadelphia 32, Pa. Check handy coupon.

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158. Big 44-page book illustrates "Gunite" uses for both repair and new construction of sewers, tanks, dams, swimming pools, and all concrete structures. A multitude of applications. Be sure to check coupon or write Pressure Concrete Co., Dept. PW, 315 S. Court St., Florence, Ala.

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Design Data on Universal Concrete Cribbing

274. Complete information on concrete cribbing for embankment retaining walls, bridge abutments, highway underpasses and other structures will be found in a new bulletin issued by the Universal Concrete Pipe Co., 297 S. High St., Columbus, Ohio. Check coupon for free copy.

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What You Should Know About Trickling Filter Underdrains

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36. "Packaged" Sewage Treatment Plants specifically developed for small communities—100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2348 Wolfram St., Chicago 18, Ill.

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How You Can Dispose Of Sewage Solids

54. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Dept. PW, Nichols Engineering and Research Corp., 70 Pine St., New York 5, N. Y.

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90. Fairbanks-Morse dual fuel engines can operate on either sludge gas or oil to provide steady power output despite fluctuations in gas supply. Bulletins are available on several sizes to meet your needs. Write, giving exact requirements to Fairbanks, Morse & Co., Dept. PW, 600 So. Michigan Ave., Chicago 5, Ill., or use handy coupon.

Need Low-Cost Air For Sewage Treatment?

122. New 20-page booklet shows operating and construction features of Rotary Positive Blowers engineered to fit your needs. Air for activated sludge, water treatment; constant vacuum for filtering. Bulletin 22-23-B-13 gives details. Roots-Connersville Blower Corp., 510 Poplar Ave., Connersville, Ind.

Engineering Data on Digester Heating

128. An excellent 32-page bulletin covering all features of the PFT External Heater and Heat Exchanger unit discusses effective digester heating, size of heater and exchanger, space requirements, building heating, and related items. Curves and tables provide full data for the designer. Requests for this comprehensive bulletin, No. 235, must be sent on business letterhead. Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.

Durable Gratings and Treads Are a Good Investment

147. Gratings for walks around settling tanks and other parts of treatment plants, both out-doors and in, for stairways, floors and balconies, are described in an illustrated 16-page bulletin by Irving Subway Grating Co., 50-53 27th St., Long Island City 1, N. Y.

Low Cost Power From Dual Fuel Engines

154. Operating on the Diesel cycle, burning either oil or gas, the Worthington Supercharged Dual Fuel Diesels give high economies by running on the cheapest fuel available. Get complete data from Worthington Pump & Machinery Corp., Dept. PW, Harrison, N. J.

Complete Catalog for Engineers Shows Water and Sewage Plant Equipment

191. The complete line of Jeffrey equipment for treatment of water, sewage and industrial wastes is covered in 52-page Catalog

833. Detailed information is provided on bar screens, grinders, grit collectors, "Jigrit" washers, sludge collectors, feeders, conveyors and other related units. Photos and drawings of installations plus capacity tables complete this valuable booklet. Use coupon or write Jeffrey Mfg. Co., 947 N. 4th St., Columbus 16, Ohio.

Data Offered On Mixed Flow Pumps

201. Data on the complete line of Worthington Mixflo pumps of the two-vane, non-clogging sewage type is offered in 16-page bulletin W-317-H16. Salient features are outlined, typical sections, performance curves and general data for five types are included. Helpful charts aid shafting selection. Copies available by using coupon or from Worthington Pump and Machinery Corp., Harrison, N. J.

Data on Design of Grit Collectors and Washers

202. Grit collection and separation of organic materials from settled grit is described in Link-Belt Bulletin 1942. Typical installations are shown, and design data is provided, together with specifications. Use coupon for copy, or write Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

How Vacuum Filters Help Your Sewage Sludge Disposal

209. Applications of the Conkey sludge filter to all types of sewage sludge are described in Bulletin 100. Tables show filter sizes, weights, and give anticipated average results. Use the coupon to order your copy. General American Transportation Corp., Process Equip. Div., New York 17, N. Y.

How to Estimate Quantity Of Joint Compound Needed

229. Directions for using Atlas G-K Sewer Joint Compound plus a handy table quantity of compound and jute required per joint of sewer pipe are presented in Bulletin M20-1. Get full data on this permanent joint material from Atlas Mineral Products Co., 10 Pine St., Mertztown, Pa., or use coupon.

●

STREETS AND HIGHWAYS

Do You Have Complete Black Top Equipment Data?

41. In 36-page catalog AA a full line of equipment for black top road construction and maintenance is covered. Units described and illustrated include several models of pressure distributors, supply tanks, sprayers, brooms, asphalt kettles, portable rollers, and accessory tools. Use coupon for copy of this handy manual. Littleford Bros., 452 E. Pearl St., Cincinnati 2, Ohio.

Grading Can Be Faster, Cheaper and Easier

96. You'll like every feature of the Austin-Western 99H Grader. It has all-wheel drive, all-wheel steer, controlled traction, precision sideshift and a high lift, extreme reach, reversible blade. Get data from Austin-Western Co., Aurora, Ill.

Spreaders for Ice Control Save Labor and Speed Job

103. Only the driver is needed to spread salt or abrasives for ice control when a Flink Tail-Gate Spreader is used. Hydraulically driven, fully automatic unit is controlled from the cab. Further details in bulletin issued by The Flink Co., Dept. 11-S, Streator, Ill. Use coupon today.

End Dangerous Ice Hazards

111. Ice prevention on highways, streets and airport runways from Sterling "Auger Action" Rock Salt is described in bulletins from International Salt Co., Scranton, Pa. Check the coupon for your copies.

How to Save Time on Curb and Gutter Work

143. Every type of curb and gutter work is illustrated in the 12-page Heltzel catalog on steel forms for building concrete curbs, gutters and sidewalks. Time-saving setups show how to speed up the job and save money. Get your copy from Heltzel Steel Form & Iron Co., Dept., PW, Warren, Ohio.

Uniform Salt Spreading Saves Material

145. The wide, thin pattern provided by Tarco "Scotchman" spreaders avoids salt waste, saves time and labor. Get Folder BL for full details on this spreader and table of material application rates. Use coupon or write Tarrant Mfg. Co., Dept. PW, Saratoga Springs, N. Y.

Versatile Maintainer Has Year 'Round Usefulness

151. A new bulletin shows how the sturdy Huber Maintainer will work for you the year 'round on maintenance jobs, berm leveling, road planing, bull-dozing, snow plowing, brooming, mowing shoulders and as a patch roller. Good ideas on how to do all these jobs in Bulletin No. M-138. Write Huber Manufacturing Co., Dept. PW, Marion, Ohio.

Manual on Retaining Wall Design

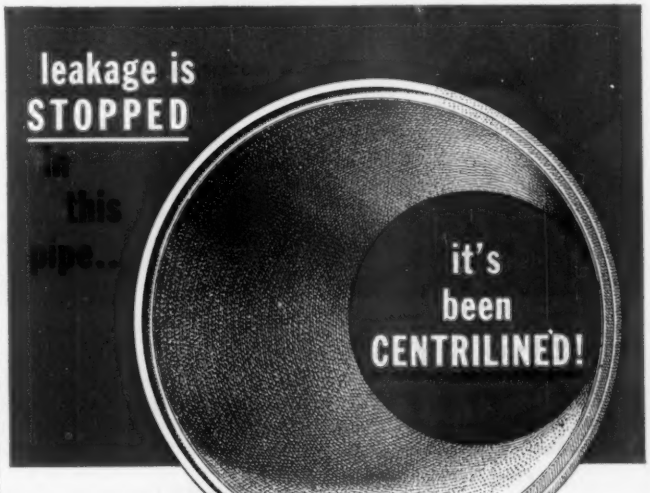
160. Embankment stabilization with Armco Bin-Type Retaining Walls is discussed in a 16-page illustrated booklet offered by Armco Drainage and Metal Products, Inc., Middletown, Ohio. Included are case histories which show embankments along highways, lakes, streams and city streets. Technical data covers selection of design and units required for various sections, curves and grades. Use the handy coupon.

Chemical Stops Salt Corrosion

174. A new chemical has been developed which, when mixed 1 pound to 100 pounds of salt, prevents any corrosion of automobiles by the salt. Harmless; colorless; odorless. Permits free use of salt for ice and snow control without complaint by drivers. Calgon, Inc., Pittsburgh, Pa.

Snow Plows for Every Street and Highway Need

227. In a new bulletin, No. 51-F, full details are given on the Frink reversible trip-blade "Sno-Plow", which has special design features to eliminate chatter and to permit quick adjustment to nine plowing positions or scraping position for ice removal. Check the coupon for your copy. Frink Sno-Plows, Inc., Clayton, N. Y.



WITHOUT REMOVING THIS PIPE FROM THE GROUND, holes resulting from exterior or interior corrosion have been permanently filled by the thin coating of cement mortar mechanically applied to the interior of the pipe by the Centriline process.

Internal corrosion has been *eliminated*. Centrilining also increases the pipe's flow capacity and cuts pumping costs.

The ingenious Centriline machine utilizes centrifugal force in applying the cement. Pipes in diameters of 4" to 144" can be lined by Centriline at *a fraction* of the cost of installing new pipes. Make pipes better than new through cement lining.

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CEMENT MORTAR LININGS FOR NEARLY 3,000,000 FEET OF WATER, OIL AND GAS MAINS . . .

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The original and most widely used plasticized sulfur jointing material, for joining bell and spigot cast iron pipe. Economical — High Quality.

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A precast rubber packing for caulking all size bell and spigot cast iron pipe.

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PRESTRESSED TANKS
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RESERVOIRS
SEWERS
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EASTERN GUNITE COMPANY
ELKINS PARK, PA.

Worth Telling

by Arthur K. Akers

★ **ROOM FOR TEN ITEMS** and three pictures vs. a 3-inch stack of important news releases and photos. So here goes Solomon, pouring a gallon into a pint measure!

★ **DON L. HINMON** succeeds E. A. PHOENIX, promoted, as assistant manager of the JOHNS-MANVILLE Transite Pipe Department.

★ **WORTHINGTON PUMP & MACHINERY CORPORATION** has appointed W. R. LEOPOLD to direct its Public Works Division. DAVE L. GALLAGHER is new manager of this division.

Mr. Leopold

Mr. Gallagher

★ **JUNIUS WALTHALL** is now UNITED STATES PIPE & FOUNDRY COMPANY'S resident representative in Florida, headquartering in Clearwater.

★ **BUILDERS IRON FOUNDRY INDUSTRIES,** Providence, announces DOUGLASS TABER as new manager of their Pittsburgh office; ALDEN CARPENTER of the Minneapolis one; RAYMOND McINDOE, assistant manager of Standard and Engineering Products Division of Builders-Providence Inc.

★ **WOLVERINE TUBE DIVISION** of Calumet and Hecla, reports E. J. CAMPBELL as sales manager; JOHN M. DUMSER, assistant to the general sales manager.

★ **DR. P. A. E. HELLIGE,** president of HELLIGE, INC., whose ads. you see monthly in PUBLIC WORKS, announces their third plant, the new one in Garden City, L. I.

★ **WHITE MOTOR COMPANY,** Cleveland, has elected WILLIAM G. STERNBERG, a vice president in charge of its Sterling Trucks division, at Milwaukee. Also ERNEST R. STERNBERG is appointed general manager of this division.

Mr. Dempster

★ When one of our good advertisers is elected mayor of his city that's *news*. Especially when he is out in front nationally anyway as one who does something about reducing municipal operating costs and improving efficiency. We give you GEORGE R. DEMPSTER, president of DEMPSTER BROTHERS taking office January 1 as mayor of his home city, Knoxville, Tenn.

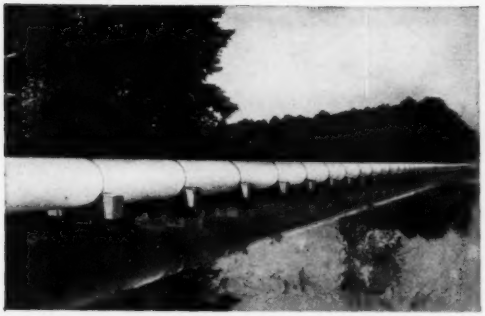
★ **CARL E. FOSS,** color consultant, of Princeton, N. J., is now a director of MACBETH CORPORATION, makers of scientific equipment, Newburgh, N. Y.

★ So we drove up the shores of lovely Lake Cayuga, where we met a Man—WILLIAM B. WILKINSON, sales manager of CAYUGA ROCK SALT COMPANY, at Myers, N. Y.—who claims he has no formal education but belied his words with the gift of a scholarly book he wrote on the romance (and facts) of the salt industry.

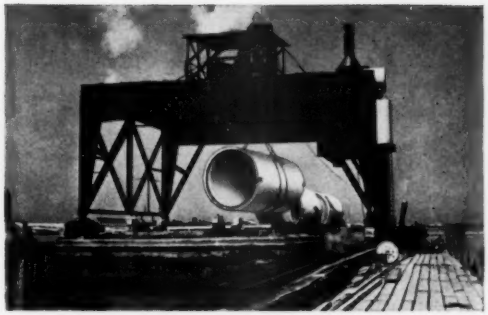
★ **TODAY'S CHUCKLE:** "How did you come to join the army?" "Well, first, I wanted to fight; second, I thought it would make me physically fit; and, last —they came and got me."

★ . . And to all my readers (if any) a Very Merry Christmas indeed.

New Hellige, Inc., plant at Garden City, N. Y.



Lee Hall Reservoir crossing, part of the 237,400′ of 24″, 27″, 34″ and 39″ Lock Joint Reinforced Concrete Cylinder Pipe supplying water to the Newport News shipyards.



Loading a section of 120″ Lock Joint Reinforced Concrete Subaqueous Pipe for 18,500′ Nottingham Intake, supplying water for the City of Cleveland.

Build for the future... with

LOCK JOINT CONCRETE PRESSURE PIPE

Tulsa's new water supply line includes approximately 280,000′ of 84″, 72″ and 66″ Lock Joint Reinforced Concrete Pressure Pipe.

Lock Joint plant where 233,000′ of 69″ and 66″ Prestressed Concrete Cylinder Pipe were manufactured for the Rio de Janeiro water supply line.

The building of a water supply line represents a large and extremely important investment. For this reason every effort is made to select the most dependable and permanent type of pressure pipe for the project. Investigation to determine the most reliable pipe available will show that Lock Joint Concrete Pressure Pipe has proven its superiority by years and years of unparallelled performance.

The permanence of Lock Joint Pipe eliminates any necessity for replacement of the line. The conservative design of its steel reinforcement avoids the dangers of blow-out or rupture while providing an ample safety factor for unusual internal pressures and heavy backloads. Dense concrete walls prohibit tuberculation or corrosion and assure extreme durability and life-long high carrying capacity.

In short, Lock Joint Concrete Pressure Pipe provides permanence, efficiency and safety for one of the most vital and essential public utilities. For your next water supply project involving pipe 1(in diameter or larger, specify Lock Joint—the pressure pipe whose future has been proven by its past.

LOCK JOINT PIPE COMPANY

Est. 1905

P. O. Box 269, East Orange, N. J.

Pressure Pipe Plants: Wharton, N. J., Turner, Kan., Detroit, Mich.

BRANCH OFFICES: Cheyenne, Wyo. Casper, Wyo. • Denver, Col. • Kansas City, Mo. Walley Park, Mo. • Wichita, Kan. • Chicago, Ill. Rock Island, Ill. • Kenilworth, N. J. • Hartford, Conn. • Tucumcari, N. Mex. • Tulsa, Okla. Oklahoma City, Okla. • Beloit, Wis. • Hato Rey, P. R.

LOCK JOINT Reinforced Concrete PRESSURE PIPE

SCOPE OF SERVICES—Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains in a wide range of diameters as well as Concrete Pipes of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.

there's an easier way...

TO OPERATE A SEWAGE PLANT, TOO

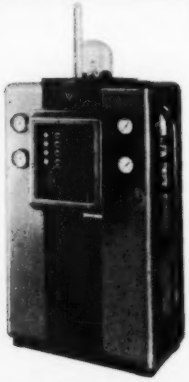
Modern equipment, such as a new W&T Visible Vacuum Chlorinator equipped for automatic or program control, can facilitate the job of operating almost any sewage plant.

For example, take a look at some of the jobs a W&T Chlorinator can do — and do well.

- Disinfect Effluents
- Control Odors
- Reduce Hydrogen Sulfide
- Prevent Sludge Bulking
- Reduce B.O.D.
- Improve Sedimentation
- Minimize Grease Content

Moreover, a W&T Chlorinator will ensure dependable, accurate chlorination with a minimum of attention and maintenance — another factor all operators appreciate.

S-71



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